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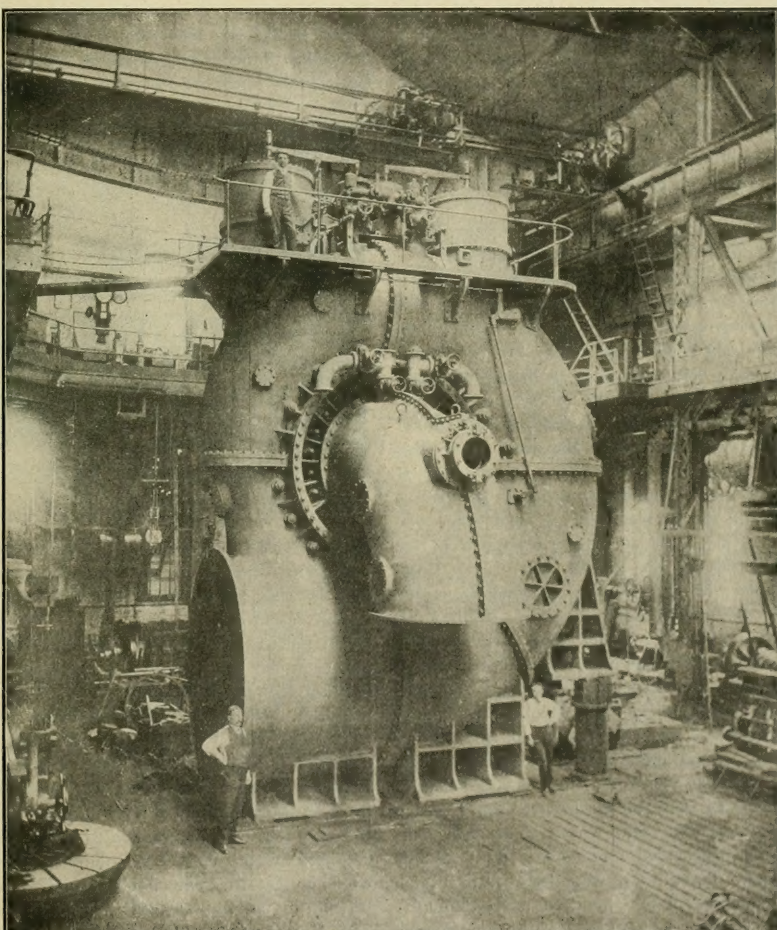
A 10,500 H. P. WATER WHEEL.

The illustration on this page represents a 10,500 h. p. water wheel which the I. P. Morris Company, of Philadelphia, recently installed in the power house of the Shawinigan Water and Power Company at Shawinigan Falls, Quebec. Some facts in regard to the turbine are interesting: It is 30 feet from base to top; 22 feet wide; weighs 364,000 pounds; shaft is of forged steel, solid, 32 feet 3½ inches long, 22 inches in diameter in center, tapering to 16 inches on the generator side and 10 inches on the other side; the distance from center to center of shaft bearings is 27 feet; the shaft weighs 10 tons; the runner is of bronze and weighs 5 tons; the intake is 10 feet diameter, and the water is discharged through two draft bends, one on either side, and one of which is shown in the illustration.



10,500 H. P. WATER WHEEL INSTALLED BY THE I. P. MORRIS COMPANY FOR THE SHAWINIGAN WATER AND POWER COMPANY.

The wheel proper is intended to operate at a speed of 180 revolutions per minute, under a head of water varying from 125 to 135 feet. The quantity of water

going through the turbine when developing the full power is 395,000 gallons per minute. Some idea of the quantity of water which this means may be gathered from the fact that it is equal to a river 88 feet wide and 10 feet deep, having a constant flow of 60 feet per minute.

The remarkably short time in which this turbine was designed and built by the I. P. Morris Company is worthy of note. The contract was not signed until May 19th, and the photograph was taken October 2nd, 1904. In shipment the turbine required five flat cars and one box car, and a special route had to be selected where the bridges were high enough to allow the huge parts to pass under.

AN INSTALLATION OF ELECTRIC POWER FOR A QUEBEC MINE.

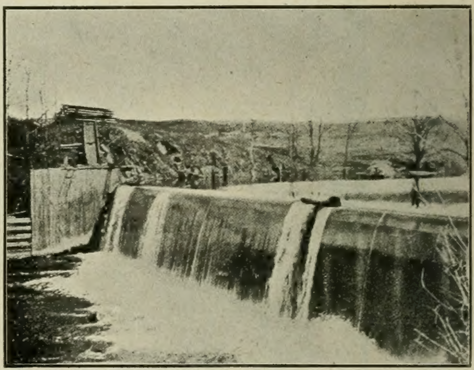
The old and important Eustis Mine at Capelton, P.Q., which has been a steady producer for over thirty years of sulphur, copper and the precious metals, has recently had important alterations made in the motive power by which its mining operations are conducted. Electricity generated by water power has been substituted for steam power, and the installation has been so arranged that in case of deficiency in, or stoppage of, the electric power a delay of only a few hours will substitute steam, so that operations under ground need not be suspended.

The annual output of the property is from 25,000 to 30,000 tons, and about 150 persons are employed.

The electricity for the plant is generated by a water power situated on the Coaticook River, about one mile above its junction with the Massawippi. At this point a wooden dam, about fifteen feet high, has been built. At one end of this dam are placed the head-gates from which a wooden pipe, seven feet in diameter, carries the water to the power house situated 340 feet farther down the river. Just outside of the power house this wooden pipe is led into a twelve-foot stand pipe or penstock, thirty feet in height, to which is connected, directly opposite the wooden pipe, a steel tube, also seven feet in diameter, which takes the water from this stand-pipe directly to the turbine case. The stand pipe is provided with an overflow, six feet above the normal water level, designed to take care of the back rush of water when the wheel gates are suddenly closed, but in practice it has been found to be seldom necessary. The water wheels are of the Crocker pattern and were built by the Jenckes Machine Company, Ltd., of Sherbrooke, P.Q.; they consist of two pairs of eighteen inch wheels mounted on one shaft. The wheels are set in one steel case, the setting being of the type known as "central discharge," that is, each pair of wheels discharges into a central draught compartment weich is provided with a single draft tube or discharge pipe. The turbines were designed to furnish 450 h.p. at a speed of five hundred revolutions per minute under a head of thirty-two feet, but the plant is now running under a head of thirty-six feet. In the design of the power house provision has been made for a third pair of water wheels, and these will be placed in an extension of the present sheet steel casing; the inlet tube is large enough to supply the three pairs of wheels without making any deficiency of water for any one of the three pairs.

The turbine shaft is directly connected to a 200 k.w. Westinghouse three phase 2,200 volt, 25 cycle, rotary field generator. The exciter has 7½ k.w. capacity and is operated at 875 revolutions per minute by a separate 9-inch Crocker turbine, which also is directly connected. The electrical controlling and connection apparatus is mounted on a single panel switchboard. The leads from the machine are brought to the board through a tile pipe laid under the floor. The power line from the switchboard is taken through the end wall of the building across the river to the mines (a distance of about two miles), and consists of three No. 1 hard drawn copper wires, spaced eighteen inches apart, in the form of a triangle on the poles.

At the receiving end of the power circuit there are three stations, one for the air compressor, one for the hoist, and one for the crushing machinery. The air compressor house is placed just outside the entrance to the mine tunnel. The compressor is of the two stage type and is a Canadian Rand Drill Company's class D-2, belt driven, cross compound machine, fitted with a Rand water tube intercooler. The cylinders are 13 inches by 18 inches and 20 inches by 18 inches, with Corliss inlet valves on the low pressure cylinder. The



VIEW OF DAM ON COATICOOK RIVER, EUSTIS MINING CO

compressor is driven by a 100 h.p. Westinghouse, 2,000 volt, constant speed, induction motor controlled by a switchboard on which are mounted the starting switch, fuses, etc.

The hoist is situated at the inner end of an adit tunnel, 1,000 feet long, through which the power is carried by three No. 4 weather proof wires, which are further protected by being placed in a heavy wooden box bolted to the rock wall of the tunnel. This hoist, which was designed and built by the Jenckes Machine Company, Limited, of Sherbrooke, Que., is placed about twenty-five feet above the tunnel level in a chamber cut out of the solid rock. It has two cast iron drums, 72 inches diameter by 48 inches face, mounted on separate shafts which are 6 5-16 inches in diameter; both drums are driven by one motor through a double set of gears. The drums are connected to the motor by friction clutches of the Lane type, and are provided with band brakes and indicators, which show the position of the skips in the shaft at all times. The clutches and brakes were designed to be controlled by levers operated either by air or by hand; in practice, so far, only the hand levers are used. The motor for the hoist is a Westinghouse 150 h.p. three-phase, 2,000 volt, type F variable speed induction motor, with a normal speed

of 480 revolutions a minute. The controller is mounted on the engineer's platform and has seven steps ; it acts by connecting different resistances, in series, with the rotating part of the motor. These resistances are entirely separate from the machine, being connected with it by means of three slip rings.

The mine incline varies from forty-five degrees to twenty degrees as depth is obtained. At present it has a depth of over 2,000 feet, and is equipped with double tracks of four feet gauge laid with 56 pound steel rails. The skips are self dumping and are not run in balance. These skips discharge into bins, the bottoms of which are about five feet above the tunnel track, which allows the cars running on the latter to be loaded through hoppers. The nominal speed of the hoist is five hundred feet a minute, but it has been found in actual practice that it only takes from five to six minutes for the skip to come from the bottom of the mine, discharge its load, and return again to the bottom. The total load hoisted (rope, skip and ore), is from 7½ to 8 tons.

The crushing plant is situated by the side of the railroad track, about three-quarters of a mile from the mouth of the tunnel. This plant is supplied with power by a branch from the main line, and the machinery at present consists of a 20 inch by 6 inch Farrel crusher with a set of geared rolls used for reducing the hard ore to fines. This hard ore occurs in parts of the mine but not in all. The two machines (crusher and rolls), are driven by a 50-horse power, 200 volt, slow speed, type C, Westinghouse induction motor, supplied through two 25 k. w. transformers. Electrical measurements indicate that these machiues take about 40 h.p. when crushing eight tons per hour. This plant is only a temporary one, to be used until the new mill, now under construction, is completed. The new mill will be driven throughout by 2,000 volt motors. It is designed to handle all the ore from the mine, and will both dress the rich ore for shipping and crush and concentrate those ores which are too lean to ship.

The hoist is so designed that, in case of accident, it may be operated by steam power by simply coupling an engine to each end of the countershaft of the new hoist, an operation which will require very little time. Steam will be supplied to the engines by old boilers, located about fifty feet away, the stacks from which consist of two tile pipes laid up the old shaft to the surface above.

The old compound steam, single stage air compressor, built by the Canadian Rand Drill Company, which is located just over the mouth of the adit tunnel, can be used in the case of low water, or, of accident to the electrically driven compressor. Steam is supplied to this old compressor by the two 125 h. p. boilers which formerly ran it.

In a recent test of the new plant it was found that, when double the full load was on the generators (a 100 per cent. overload test) the level of the water in the stand pipe was below its normal point, and that the water in the tail race was above the normal point ; these water levels, both above and below, fluctuated rapidly and it was difficult to gauge them accurately with the means which were on hand at the time of the test. The actual head of water on the turbines is supposed to have been thirty-three feet, and if this assumption is correct the water wheels would have used, theoretically, 706 horse power of water, of which amount about 18 h. p. was consumed in the exciting generator. Allowing the main generator to have used 688 h. p. and on the assumption that it developed one hundred ampere per phase at a voltage of 2,160, and on the further assumption that the efficiency of the generator at this overload was 92 per cent., and that the power factor of the circuit (water rheostat) was unity, the brake horse power developed would have been about 543 h.p., which would give an efficiency of 78.9 per cent. for the water wheels. As the electrical measurements were not accurately taken, and as the head of water (as already mentioned) fluctuated, the results are doubtful, but the probability is that the efficiency was less, rather than greater, than the above figures. Similar tests made with the wheels operating at partial load, and therefore partial gates, showed that the efficiencies at 271 and 390 e.h.p. were respectively 51 per cent. and 65 per cent. approximately. The 271 e h.p. would represent the conditions under which the plant operates while the hoist and compressor are in use.

As the hoisting plant is quite unusual in its use of induction motors, the following consumption of power for the various stages of the hoist is given. These figures were taken by Mr. Davis (the electrician in charge), and are readings from his electrical instruments.

The method adopted in hoisting is, on receipt of the mine signal to start the motor light, and after it has gotten up to a fair speed to pick up the load with the friction and then throw the controller over to full speed. It will be noticed that this method of starting saved nearly 100 e.h.p. over the method of starting the load when the motor was at rest.

Starting Motor Light.

Instantaneous starting current.	96 h. p. for	5 seconds.
After starting with load on....	126 " "	10 "
Full load full speed..........	107 " "	

Starting Motor with Load On.

Starting current.............191 h. p. for 20 seconds.

This adoption of electricity for motive power in mining is the first we have knowledge of in Quebec ; in British Columbia the Granby Consolidated Company have made an electric installation for tramming, crusher and other purposes.—Canadian Mining Review.

An important amalgamation of electric railway interests in Toronto has taken place, and a new company has been organized under the name of the Toronto and York Radial Railway Company. Mr. William Mackenzie is president and M. W. H. Moore general manager. The amalgamation includes the Metropolitan Electric Railway, the Mimico Electric Railway and the Scarboro Electric Railway.

The German navy officials are giving close study to the possibilities of gas engines for propelling war ships. At a recent meeting of the German Society of Naval Architects, Mr. Capitaine, of Frankfort-on-the-Main, predicted that gas would displace the present steam engines as well as turbines, and by means of models showed that gas could be successfully adapted to driving marine engines.

The Hamilton Cataract Power, Light & Traction Company recently started the two 5,000-kilowatt Westinghouse generators in their DeCew Falls power station. Power is supplied from Welland Canal feeders, tapped in about 14 miles above the power station, and at the station the water has a head of 267 feet. The Westinghouse generators are of the two-bearing type, direct connected to Escher-Wyss water-wheels, and run at a speed of 286 r.p.m. They generate 3-phase current at a frequency of 66 cycles, and a pressure of 2,400 volts.

THE DEVELOPMENT OF THE GAS ENGINE AND ITS APPLICATION TO ELECTRIC CENTRAL STATION SERVICE.

By R. T. MacKeen.

A brief review of the history of industrial development during the past century furnishes convincing evidence of the natural tendency toward the economic production of the necessities of life demanded by advancing civilization. The problem which stands pre-eminent among the many to be solved in modern times is that of cheap production and resulting minimum cost to the consumer. The solution of this problem will require the application of all the skill and ingenuity that the best men of the present and future years can supply, to keep pace with the demand.

Perhaps in no other field is this fact of greater importance than in that affecting the economical production of energy, or more properly the economical transformation of the energy stored up in our natural resources to a form in which it can be applied directly to the multitudinous uses created by modernizing influences.

The two great sources of energy at present available are those of water power and the element carbon. The development of the former is limited by considerations of location and accessibility, but the latter, due to its wide distribution and the ease with which it is rendered available, has for many years been the chief source of obtaining energy, and has, in consequence, merited the greatest attention and study of engineers engaged in industrial enterprises.

The subject of this paper is one immediately concerned with the economical transformation of natural energy into a form suitable for application to industrial processes. For many years this transformation of the energy stored up in coal has been accomplished through the medium of the evaporation of water into steam, and the utilization of the expansion of the latter to reproduce the original thermal energy in the kinetic form.

While the steam boiler and steam engine have been developed to a surprising degree of efficiency, the former thermally, and the latter mechanically, yet the transformation of the thermal energy contained in the steam into kinetic energy in the engine is attended by such losses that the maximum combined efficiency of boiler and engine is exceedingly low. For instance, the thermal efficiency of an average boiler operating under normal conditions rarely exceeds 70 per cent. and that of the engine 18 per cent., thus the combined efficiency is but 12.6 per cent. This means that out of the energy contained in one pound of coal, but 12.6 per cent. is available in the form of kinetic energy at the engine piston. Thus, any means whereby a more economical transformation can be secured merits our closest study and investigation.

The principal causes of the low efficiency of the above method of energy transformation are as follows: Incomplete combustion; inefficient utilization of the heat produced in the evaporation of water; heat lost by radiation at the boiler; heat lost by radiation from steam in its conveyance to the steam engine; radiation of heat at the engine; and the inefficient transformation of the thermal energy of the steam into kinetic energy through expansion. It is thus evident that the adoption of any means whereby the efficiency of these various operations can be improved, will result in a more economic production of kinetic energy.

As a result of investigation along the lines indicated, the development of the gas engine has, of recent years, reached such a stage that it now promises to form a potent factor in the development of power in the near future to the exclusion of steam power in a great many instances. The underlying principle of the gas engine might be stated as follows: The ecomonic transformation of thermal energy into kinetic energy by means of converting the combustible into a gas through a highly efficient process, conveying this gas to a cylinder similar in many respects to a steam engine cylinder, and there, by means of further combustion, transforming the thermal energy contained in the gas to the kinetic form.

Nature has in many cases completed the first transformation by providing natural gas in various districts, and hence losses incidental to the first transformation are avoided, where this gas is available. In this discussion, however, we shall consider the effecting of the first transformation by means of apparatus designed for the purpose and known as a "gas producer."

To illustrate the relative thermal efficiency of the energy transformation possible by means of a steam engine and a gas engine plant, let us make the following assumptions, all the values being readily obtainable in practice.

Calorific value of coal per lb. = 12500 British Thermal Units.	
Thermal efficiency of producer for gas engine	80%
Thermal efficiency of gas engine	25%
Thermal efficiency of steam boiler	70%
Thermal efficiency of steam engine	18%

Thus for the gas engine we have for one pound of coal in the form of kinetic energy at the gas engine piston $12500 \times .80 \times .25 = 2500$ B.T.U.

The thermal equivalent of one horsepower = 2545 B.T.U.

Thus one h.p. at engine piston will require $\frac{2545}{2500} =$ 1.02 lbs. of coal.

For the steam engine, one pound of coal consumed at the boiler will furnish in the form of kinetic energy at the engine piston $12500 \times .70 \times .18 = 1575$ B. T. U. equivalent to $\frac{2545}{1575} = 1.62$ lbs. of coal per h.p.

Hence it will be noted that the coal required to produce one h.p. of kinetic energy at the piston of the gas engine is but 1.02 lbs., as against 1.62 lbs. for the steam engine, thus effecting a saving of 57% in coal.

Having furnished a comparative idea of the relative efficiency of the two methods of energy transformation, let us now consider in detail the principle of the gas engine and its auxiliary, the producer.

Gas engines are broadly divided into two classes. The four-stroke, and the two-stroke, cycle engine. In the single acting type of the four-stroke engine there is but one power stroke in every four, the other three strokes being necessary to effect exhaustion, suction and compression, as illustrated in Fig. 1. In the single acting two-stroke cycle engine every alternate stroke is a power stroke. This is accomplished, however, at the expense of simplicity of design and the use of auxiliary apparatus, which has rendered the four-stroke cycle engine of more general adoption.

In the simplest form of the four-stroke cycle engine illustrated in Fig. 1, the cycle of operation is as follows:—The cylinder, at the moment indicated, is filled with the right proportion of gas and air compressed to the proper degree, and is then ignited either by

means of a fire tube or an electric spark. The chemical reaction upon ignition results in what may be termed an explosion, and the resulting pressure causes the piston to move forward to the end of its stroke. Upon the return stroke the burned gases are exhausted through exhaust ports. The remaining momentum of the moving parts causes the third stroke to take place, at which time, through the suction produced, a fresh mixture of gas and air enters the cylinder and the return or fourth stroke still caused by momentum of the moving parts compresses the mixture to the proper degree. At the next forward stroke the mixture is again exploded, and energy is again imparted to the moving piston, and thus each cycle is completed successively.

It is evident that as only one power stroke occurs in each four strokes, the energy imparted to the piston is not constant, resulting in a varying angular velocity of the revolving elements of the engine and hence irregular power output. In order to overcome this undesirable feature various modifications of the simple acting engine have been effected, as illustrated in Figs. 2 and 3. In Fig. 2 we have a double acting single cylinder engine furnishing two power strokes in every four and in Fig. 3 is illustrated a tandem double acting engine in which every stroke is a power stroke. By this means the energy transformation takes place

FIG. 1

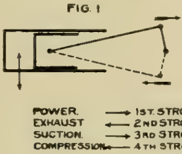


FIG 2.

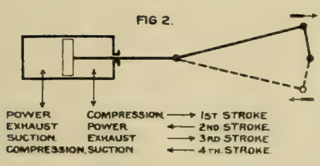
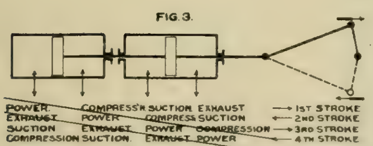


FIG 3.



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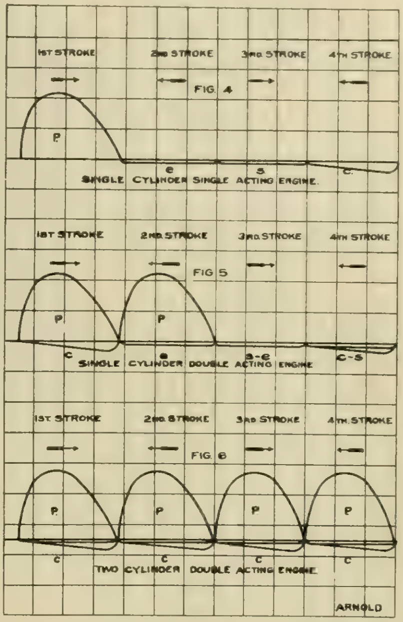
at more frequent intervals and hence the variation in the velocity of the moving elements is reduced to a minimum. Other modifications, such as a combination of several sets of single acting, double acting or tandem double acting cylinders linked to cranks at 90 degrees apart, still further improve this characteristic.

A clear idea of the relation between the number of power strokes to the cycle of the engine is furnished by Figs. 4, 5, and 6. In Fig. 4 we have one power area per cycle, corresponding to the single acting engine in Fig. 1. In Fig. 5 we have two power areas per cycle, corresponding to the engine illustrated in Fig. 2, and in Fig. 6 four power areas per cycle, corresponding to the engine illustrated in Fig. 3. Further provision is made for obtaining a constant angular velocity of the engine shaft by the use of heavy fly wheels proportioned to meet the characteristics of the engine.

The performance of the modern gas engine as also



that of the steam engine does not even approximate the theoretical by reason of the impracticability of utilizing in the form of kinetic energy all the thermal energy contained in the expansive medium, whether gas or steam. The maximum theoretical thermal efficiency of the gas engine approximates 58 per cent., yet due to the fact that the total expansive energy cannot be utilized, the net efficiency does not exceed a maximum of 26 per cent. This figure is, however, much higher than that possible with the steam engine, which under the best operating conditions rarely exceeds 18 per cent. A typical performance chart of a modern gas engine is furnished in Fig. 7. From this it will be noted that the thermo-dynamic efficiency at full load reaches 25 per cent., and the mechanical efficiency 89 per cent. In this test Pittsburg natural gas was used as fuel, having a calorific value per cubic foot of 1,000 B.T.U.

There are several distinct fuel gases available, suitable for gas engines. These are enumerated below, with their respective calorific values per cubic foot.

	Approx. B.T.U. per cu. ft.	
	Gas.	Mixture.
Natural gas	1000	91.0
Coal gas	650	91.7
Carburetted water gas	600	92.0
Coke oven gas	600	90.0
Water gas	300	88.0
Producer gas	120-145	60-68
Blast furnace gas	90	53.0

By "mixture" is meant the best proportions of mixed gas and air to produce complete combustion in the engine cylinder, and hence maximum transformation of energy.

It will be noted that with the exception of the blast

furnace gas, all the calorific ratings of the mixtures are approximately equal. If gases poor in calorific value are used larger cylinders are necessary to accommodate the increased quantity required to compensate for the poorer quality to produce the same amount of energy.

The producer, corresponding to the boiler of a steam plant, and in which the carbon of the coal s transformed to a gas, is of several ;forms, depending upon the character of the fuel to be used. They are, however, the same in principle. The producer ordinarily consists of three elements ; the generator, somewhat similar to a blast furnace on a small scale, a scrubber, for cooling and removing impurities from the gas, and a steam boiler heated by the gas produced in its passage to the scrubber, the steam being necessary for the operation of the generator. A gas holder also forms part of the equipment, by means of which the gas can be stored, acting in this respect as a reservoir.

Producer gas at present offers the greatest possibilities for utilization in gas engines, due to its comparative cheapness and the high efficiency and simplicity of the generating apparatus.

A comparison of the approximate thermal efficiency of the various gas processes are as follows :

Coal gas (without coke)	24%
Coal gas (coke included)	60%
Water gas	60%
Producer gas	80%

Considering now the question of the relative economy of gas and steam engine plants as applied particularly to the generation of electrical power in central stations, we must view the comparison from two main standpoints :

First.—The initial cost and fixed charges of the equipment.

Second.—The cost of maintainance and fuel.

The cost of a gas engine plant, including engine, producer, holder and auxiliaries installed, is approximately from 40 to 50% more than for a corresponding steam engine plant designed for the same maximum output.

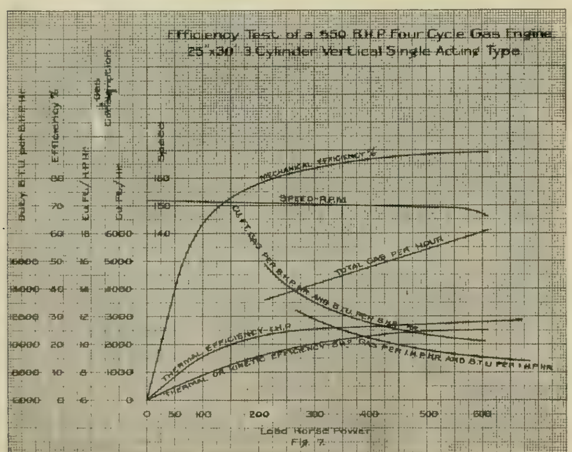
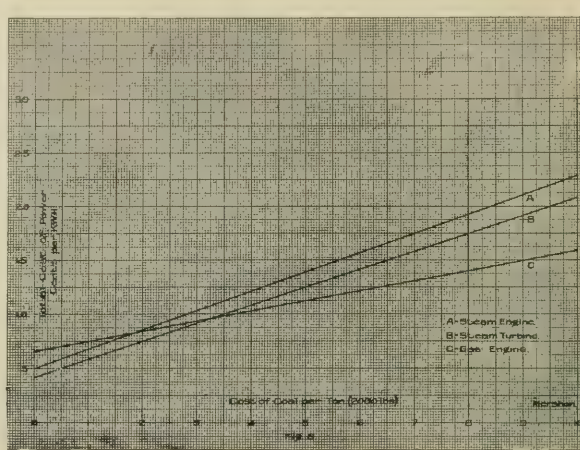


Fig. 7.

The depreciation of the gas engine in practice has not exceeded that of the steam engine, and as the same rates of interest, taxes and insurance, apply to both, the fixed charges of the gas plant will be considerably in excess of those for the steam plant.



The fuel consumption of the gas plant will approximate one-half that of the steam plant for the same output, hence the cost of fuel is the principal factor in determining which investment will ultimately prove more profitable upon a basis of assumed initial cost.

Another consideration which here enters into the comparison is that of maintenence. It is generally admitted by gas engineers that this item is materially higher for the gas than for the steam plant, yet to offset this it is claimed that the standby losses of the steam plant fully compensate for this excess.

The average efficiency of a producer gas plant may be taken as 80 per cent. Assuming a calorific value of medium grade coal as 12,500 B. T. U. per lb., the heat available at the engine cylinder is 10,000 B.T.U. The thermal efficiency of the engine may be assumed as 25%, thus 2500 B. T. U. are utilized in producing kinetic energy in the engine. The thermal equivalent of a horse power is 2545 B. T. U., thus in the case considered the production of one h. p. of kinetic energy requires in the gas plant a consumption of $\frac{2545}{2500} = 1.02$ lbs. of coal.

The mechanical efficiency of the engine may be taken as 88%, thus a duty of $\frac{1.02}{.88} = 1.16$ lbs. of coal per brake horse power hour may be expected from a well designed gas power plant. Instances are recorded where a fuel consumption of as low as .9 lbs. of coal per B. H. P. hour have been obtained from plants utilizing by-products from the producer plant.

The best economy recorded for high-class steam engine plants averages 3 lbs. of coal per B. H. P., but

this figure is representative of plants operating under exceptionally favorable conditions.

In the following relative comparison of the economy and ultimate profitable investment for a gas plant and a steam plant we have assumed a consumption of 2 lbs. of coal per k.w. hour for the gas plant and 4.5 lbs. per k. w. hour for the steam plant as representing the results which would be obtained in a 1000 k. w. plant operating under ordinary conditions, with a load factor of 50% for 20 hours per day for 310 days per year.

ASSUMPTIONS.

	Steam.	Gas.
Rated capacity output	1000 Kw.	1000 Kw.
Pounds Coal per Kw. hour	4.5	2
Cost of coal at plant, per ton (2000 lbs)	$3.00	$3 00
B. T. U. per lb. of coal	12500	12500
Average load, 50% L. F.	500 Kw.	500 Kw.
Hours operation per day	20	20
Days per year	310	310
Total hours per year	6200	6200
Depreciation	10%	10%
Interest	5%	5%
Taxes, Insurance, Etc.	2%	2%
Life of Plant	10 years	10 years
Cost of plant installed complete with auxiliaries, based upon a B. H. P. output capable of carrying continuously 25% overload capacity of generators and 50% overload for two hours and 100% momentarily	$100.00	$150 00

EQUIPMENT.

	Steam.	Gas.
Cost of equipment	$100 000.00	$150,000 00
Interest, 5%	$5,000.00	$7.500.00
Depreciation	$10,000.00	$15.000.00
Taxes, insurance	$2,000.00	$3,000 00
Total fixed charges	$17,000 00	$25.500.00
Total fixed charges per kw. capacity	$17.00	$25.50
Excess gas over Steam, per k.w.		$8.50
Excess gas over steam for 10 years, per k.w		$85.00
Excess fixed charges gas over steam, per 1000 k.w. per year		$8,500.00
Excess gas over steam for 10 years per 1000 k.w.		$85,000.00

COMPUTATION.

	Steam.	Gas.
Total k. w. hours per day	10,000	10,000
Total k. w. hours per year	3,100,000	3,100,000
Cost of fuel per k. w. hour	.675 cts.	.30 cts.
Cost of fuel per day	$67 50	$30.00
Cost of fuel per year	$20,925.00	$9,300.00
Saving in cost of fuel for gas plant over steam plant, per year		$11,625 00
Ditto for ten years		$116,250.00
Excess fixed charges gas plant over steam plant for 10 years		$85,000.00
Saving in total cost operating and fixed charges of gas plant over steam plant for 10 years		$31,250.00
Cost of fuel per k. w. per year	$20 92	$9 30
Cost of fuel per k. w. for 10 years	$209.25	$93.00
Saving in fuel cost gas plant over steam plant per k. w. for 10 years		$116.25
Excess fixed charges gas plant over steam plant per k. w. for 10 years		$85.00
Net saving gas plant per k. w. for 10 years		$31.25

From the above computation it will be noted that a saving of $31.25 per k. w. for ten years, the assumed life of the two plants, will be realized. This saving amounts to $3,125.00 per year, which capitalized at 5 per cent. would permit an increased working capital of $62,500.00, or, on the other hand, assuming 17% as the total fixed charges, this amount would permit of an increased cost of $18.38 per k. w. for the gas plant, and still be on a parity with the steam plant.

Viewed from still another stand-point, this saving of $3,125.00 per year might be considered as revenue for the payment of increased dividends.

The ultimate investment for the gas plant from above computation would appear to be profitable than for a corresponding st

previously stated, this fact is influenced almost entirely by the cost of fuel. To illustrate this point: From the above assumptions and computation, if the fuel had cost $2.19 per ton instead of $3.00, the two plants would be on a parity. In other words, the saving in cost of fuel at $2.19 per ton would just equal the excess fixed charges of the gas plant over the steam plant.

In further connection with this point, we furnish in Fig. 8 curves prepared by Mr. R. D. Mershon, illustrating the relation between the total cost of power per k. w. hour and the cost of coal per ton for a gas engine, steam engine and steam turbine plant. The points at which the Curve C. intersects the Curves A. and B. indicates on the abscissæ the cost of coal per ton at which the steam engine and steam turbine plants would be on a parity with the gas engine plant. These curves are based upon the following assumptions, and curves for individual cases based upon other values must be specially computed.

Maximum peak load 1,500 k. w. load factor 50%. Four generator units each of 400 k. w. operating when necessary at 25% overload. Calorific value of coal 12500 B.T.U. per lb. evaporating in the boiler 7 pounds of steam per pound of coal. Steam pressure 150 lbs., 150° F. superheat. Efficiency of gas producer plant, 80%. Under these assumptions the following figures for performances are taken. Steam engine, 12 lbs. of steam per B. H. P. hour; steam turbine, 18 lbs. per k. w. hour; gas engine, 10,000 B. T. U. per B. H. P. hour.

NIAGARA POWER.

Two generating sets of the Canadian Niagara Power Company's plant at Niagara Falls were set in motion on Monday, January 2, 1905. The units are of 10,000 h. p. each and were speeded up to a capacity of 250 revolutions per minute, the test being perfectly satisfactory. Mr. W. H. Beatty, president of the Canadian Niagara Power Company, turned the wheel that governed the flow of water from the penstock to the turbine, while a number of prominent persons were present in honor of the occasion. The company intend to install eleven units of 10,000 h.p. each, making a total capacity of 110,000 h.p.

The Ontario Power Company and the Electric Development Company are making satisfactory progress with their development work, although their plants will not be completed for some time. It was only recently announced that the Ontario Power Company had made a contract with the Niagara, Lockport and Ontario Power Company to deliver 30,000 electrical horse power to them at the international boundary line at or near the Whirlpool on July 1, 1905, and an additional 30,000 horse power by January 1, 1907. This contract was made for a period extending to April 1, 1950, with renewal rights for 60 years more, or to 2010. Under the agreement the Niagara, Lockport and Ontario Company are to erect a transformer station on the American side near the point of crossing and to construct a transmission line as far as Roches- N. Y., by July 1, 1905. These contracts indicate some of the product of the Ontario Power Company will find its way to a market on the New York side.

ELECTRIC RAILWAYS IN CANADA.

Through the kindness of Mr. D. A. Starr, general manager of the Clyde Valley Electrical Power Company, Glasgow, Scotland, we are permitted to publish below some valuable statistics of the electric railways of Canada. The data has been compiled from the Dominion Government reports, but with the details worked out more fully. The returns furnished by the Government are in some cases slightly inaccurate, but those pertaining to traffic are, we believe, as nearly correct as possible. Mr. Starr has for several years prepared similar data, which he has found very useful.

Work will be commenced the coming spring on a long-distance telephone line between Indian Head and Regina, N.W.T.

HOW TO HANDLE A HOT BEARING.

By a hot bearing is meant when a "well-behaved" journal and bearing begins to get sizzling hot, due to the lack of oil, poor oil, presence of some gritty substance, or sudden non-alignment.

The first thing on the program is for the engineer to be calm and collected and not get excited.

A hot crank pin provided with a centrifugal, center or telescopic oiler : Flood the pin with oil (preferably cylinder oil) as quickly as possible, through the center oiler arm, or telescopic tubes, mingled with water, if water is handy.

If you have an assistant, station him at the throttle immediately. Keep on pouring in the oil and water and keep the engine running. If the babbitt begins to run or fly, you can make up your mind that the oil holes are stopped up with babbitt ; then check the en-

ELECTRIC RAIL

Data of Mileage, Earnings, Expens

		Hull Electric Co'y	Niagara, St. Catharines & Toronto	Oshawa Electric Ry	Galt, Preston & Hespeler	Montreal Belt Line	Hamilton, Grimsby & Beamsville	Hamilton Radial Electric Ry	Hamilton & Dundas Electric Ry	Metropolitan Elec. Ry Toronto
Track Mileage	Double Track	685								
	Single Track	1563	1994	8.2	90	1410	230	120	7.25	28.0
Gauge		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
Sidings	Length of in miles	2.	215					.50		2
No. of Junctions with Steam Railways		2	2	1	1	1	1	2	2	
Rolling Stock	Passenger Cars	21	13	9	11	27	9	13	4	20
	BM & Express Cars									2
	Engines (electric)	1		1						
	Freight Cars		16	3	3	2	8	1	1	5
	Snow Ploughs	2	1			2	1			1
	Snow Sweepers	1	1	1	1			1		
Capital Liabilities	Share Capital (paid up)	$\$$292,000	925000	40,000	31,310	750,000	200,000	75,000	100,000	450,000
	Preferred Stock			Bonus 27,400		Bonus 450,000	Bonus 28,000			
	Bonded Debt		594,000	88,452^{16}			85,000		100,000	
	Floating Debt		247,657^{05}	10,890^{81}	100,000	52,552^{23}	10,617			550,000
	Total	$\$$292,000	1,766,657^{05}	166,742^{97}	131,310	1,252,552^{23}	323,617	75,000	200,000	1,000,000
Capital Liabilities per mile of Single Track		$\$$	79,975^{42}	20,790^{89}	14,590	88,833^{49}	14,070^{30}	6,000	27,586^{21}	33,333^{33}
Cost	Railway & Rolling Stock	$\$$749,279^{95}	1,344,746^{84}	192,784^{29}	123,014^{91}	813,805^{36}	202,050	101,738^{95}	248,906^{70}	690,905
	Railway, per mile, Single Track	$\$$	60,875^{82}	24,037^{94}	13,668^{33}	57,716^{69}	8,784^{78}	8,133^{12}	34,331^{86}	23,030^{7}
Earnings	Passenger Traffic	$\$$47,265^{90}	63,321^{00}	7,783^{12}	18,049^{11}	43,888^{63}	44,612^{98}	43,648^{22}	24,718^{68}	66,056^{97}
	Freight Traffic	$\$$7,789^{99}	31,392^{22}	40,337^{65}	11,225^{18}	9,273^{90}	11,266^{68}	3,069^{50}	1,652^{38}	6,176^{85}
	Mails & Express	$\$$600^{00}	659^{93}	2,183^{89}		500^{00}	5,180^{13}		75^{33}	2,000^{00}
	Other Sources	$\$$18,293^{48}	1,313^{53}	1,619^{57}	828^{35}	2,900^{86}	1,471^{85}	1,461^{26}	6,661^{89}	569^{27}
	Total	$\$$73,949^{37}	96,686^{68}	51,934^{25}	30,102^{64}	56,563^{39}	62,531^{64}	48,178^{98}	33,108^{28}	74,803^{09}
Operating Expenses	Maintenance, Lines, Buildings	$\$$11,997^{83}	7,985^{83}	8,476^{38}	4,777^{25}	1,069^{63}	6,815^{77}	1,935^{09}	6,098^{65}	8,126^{92}
	Working & Repairs to Motors & Cars	$\$$11,074^{70}	8,899^{70}	10,188^{10}	11,639^{15}	9,520^{50}	11,122^{00}	9,751^{59}	3,335^{88}	34,279^{74}
	General Expenses	$\$$36,006^{96}	53,283^{83}	16,604^{08}	9,972^{58}	16,169^{01}	13,230^{25}	12,004^{45}	8,855^{19}	2,967^{73}
	Total	$\$$59,079^{48}	70,769^{36}	35,268^{56}	26,388^{98}	26,759^{13}	31,168^{62}	23,791^{13}	18,282^{75}	45,374^{39}
	Nett Earnings	$\$$14,869^{88}	25,917^{32}	16,655^{67}	3,713^{66}	29,804^{26}	31,368^{02}	24,387^{85}	14,825^{53}	29,428^{70}
Mileage	Passenger Trains	388,654	210,462	40,299	72,310	215,764	248,746	199,534	71,638	250,000
	Freight Trains	15,163	288,000	21,323	12,350	20,124				40,000
	Total	403,817	498,462	61,622	84,660	235,888				290,000
Passengers Carried		705,476	602,035	33,853	289,292	431,953	345,639	581,583	290,904	521,083
Freight Carried (in tons of 2000 lbs)		54,452	92,248	66,370	31,058	35,316	6,380	2,400	1,230	800
Earnings	Per Passenger (cents)	6.7	10.52	581	624	1016	12.91	7.5	8.5	1268
	Per Ton Freight (")	1431	3403	6077	3614	26.26	176.59	1299	13434	7.72
	Total per Train Mile (cents)	18.31	1904	8426	3555	23.98	2514	2415	46.22	2579
Expenses, total per train mile (cents)		1463	1402	5723	31.17	1134	1253	11.93	2552	1565
Passengers carried per train mile		182	2.86	332	4	1.83	1.39	291	406	18
Freight carried per train mile (tons)		35	.32	311	257	.57				02
Proportion of Expenses to Earnings		7989%	73.2%	6792%	87.66%	4731%	4984%	4938%	5522%	6066%
Remarks		Water Power	Two Steam Power Houses	Steam Power	Steam Power	Steam Power	Steam Power	Steam Power	Water Power Supplied by Cataract Co'y	Two Steam Power Houses Package Freight Only

		Montreal Park & Island Ry	Guelph Electric Ry	Montreal Street Railway	Toronto Railway	Ottawa Street Railway	Quebec Rlwy Montmorency Div	Quebec Rlwy Citadel Div	Hamilton Elec. St. Ry.	Winnipeg Street Ry
Track Mileage	Double Track	1275		4578	46.87	18.28	6.00		10.50	5.00
	Single Track	1249	5.5	2509	300	3.57	13.00	17.22	1	1000
Gauge		4'8½"	4'8½"	4'8½"	4'10⅞"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
Sidings	Length of in miles	2.3	.33	9.12	5.75		4.50			
No. of Junctions with Steam Railways		4	1	6	2	2	2		1	
Rolling Stock	Passenger Cars	41	8	720	705	102	10	66	81	76
	BM & Express Cars									
	Engines (electric)					3				
	Freight Cars	14		19	3	1		1		1
	Snow Ploughs	1		2	2			2		
	Snow Sweepers	2		20	13	7		6	2	2
Capital Liabilities	Share Capital (paid up)	720,900	47,545^{53}	6,000,000	6,539,690	814,800	1,000,000	1,000,000	205,000	
	Preferred Stock	315,000					Bonus 402,945^{54}	212,620		
	Bonded Debt	1,025,000	48,000^{00}	2,473,333	3,473,373^{33}	500,000	1,000,000	500,000	500,000	
	Floating Debt	599,947^{61}	95,545^{53}	706,175^{67}	352,650^{53}	161,296	112,153^{48}	112,153^{48}		
	Total	2,660,847^{61}		9,179,508^{67}	10,365,713^{86}	1,476,096	2,515,098^{94}	1,824,773^{48}	705,000	
Capital Liabilities per mile of Single Track		67,487^{94}	16,388^{60}	72,519^{42}	101,138^{78}	50,276^{76}	65,257^{59}	105,968^{24}	32,045^{45}	
Cost	Railway & Rolling Stock	2,190,580^{64}	90,927^{51}	8,470,238^{92}		1,523,498^{31}	2,476,915^{47}	1,159,361^{90}	970,989^{50}	1,095,168^{00}
	Railway, per mile, Single Track	54,737^{14}	15,596^{48}	66,916^{05}		37,324^{91}	83,963^{23}	67,326^{47}	44,135^{68}	54,758^{4}
Earnings	Passenger Traffic	136,367^{85}	16,104^{55}	2,125,480^{32}	1,987,258^{94}	328,100^{22}	82,371^{39}	186,905^{69}	180,578^{73}	230,341^{5}
	Freight Traffic	2,350^{71}	954^{19}							
	Mails & Express					4,000^{00}	562^{53}	750^{00}		
	Other Sources	1,622^{90}		37,489^{35}	12,808^{40}		864^{86}		3,059^{09}	1,170
	Total	140,341^{52}	17,058^{74}	2,162,969^{67}	2,000,067^{34}	332,100^{22}	83,798^{78}	187,655^{69}	183,637^{82}	231,511
Operating Expenses	Maintenance, Lines, Buildings	22,293^{65}	3,706^{51}	167,481^{91}	57,723^{50}	28,771^{79}	13,652^{04}	21,316^{29}	9,601^{64}	7,605^{04}
	Working & Repairs to Motors & Cars	59,937^{58}	12,893^{88}	398,412^{92}	392,374^{49}	35,483^{48}	9,448^{34}	9,296^{31}	41,005^{18}	49,232^{01}
	General Expenses	50,595^{18}	284^{53}	716,040^{77}	681,828^{18}	128,022^{67}	27,184^{34}	98,909^{16}	67,354^{06}	66,463
	Total	132,826^{41}	16,884^{92}	1,281,935^{60}	1,131,976^{77}	192,277^{94}	50,284^{74}	129,521^{76}	117,960^{88}	123,301
	Nett Earnings	7,513^{11}	. 173^{82}	881,034^{07}	868,090^{57}	139,822^{28}	33,514^{04}	58,133^{93}	65,676^{94}	108,210
Mileage	Passenger Trains	720,015	196,200	11,232,924	11,040,257	2,290,065	176,977	1,179,033	1,190,180	1,196,503
	Freight Trains	8,508	550							
	Total	728,823	196,750							
Passengers Carried		1,515,451	380,123	53,017,467	48,619,704	7,649,850	666,460	4,424,127	4,353,637	5,341,542
Freight Carried (in tons of 2000 lbs)		11,438								
Earnings	Per Passenger (cents)	9	423	4	4.08	4.29	12.36	422	415	431
	Per Ton Freight (")	2055								
	Total per Train Mile (cents)	1925	8.67	1925	1812	14.5	4735	1598	1543	1935
Expenses, total per train mile (cents)		1822	8.58	11.41	1025	84	2841	1099	991	103
Passengers carried per train mile		208	1.95	4.72	404	334	3.76	3.75	366	446
Freight carried per train mile (tons)		13								
Proportion of Expenses to Earnings		9464%	99%	5927%	5659%	579%	60%	6902%	6423%	53.26
Remarks		Steam Power	Steam Power	Steam & Water Power Rented from Chambly Co	Steam Power	Water Power	Water Power Rented from Montmorency	Water Power	Water Power Supplied by Cataract Co'y	Steam Power

COMPILED FROM DOMINION GOVERNMENT REPORTS

gine down so that "she" just "turns over," follow the crank pin around with an oil can, full of cylinder oil, and get the oil down to the pin by the sides and ends of the brasses. Continue this operation with the engine barely "turning over," until you feel satisfied that the oil has worked in between the pin and the brasses, or until it begins to cool off; then you may will rub off the pin on the high points of the brasses. A crank pin brass should only bear or touch the pin in the center of the brass, the full length of the pin.

A hot crank pin that is not provided with a centrifugal, center or telescopic oiler: Slow the engine down immediately, so that it is just "turning over" and that is all. Follow the crank pin around with an

.YS IN CANADA

he Year Ending June 30th, 1903.

Electricity	Niagara Falls Park & River Ry	Sandwich, Windsor & Amherstberg	Grand Valley Electric Rlwy	Sherbrooke Street Rlwy	Toronto & Mimico Ry	Levis County Electric Ry	Cornwall Street Ry	Sarnia Street Ry	Yarmouth Street Ry	Berlin & Bridgeport Electric Ry	Toronto Suburban	Cape Breton Electric Ry	Port Arthur Street Rlwy	Nelson Tramway	Wesley Park & Clifton	Toronto & Scarboro	Woodstock Thames Valley & Ingersoll	Port Dalhousie St Catharines & Thorold	International Transit Co	Brantford Street Ry	Kingston, Portsmouth & Cataraqui	British Columbia Ry
	1143	.5	See remarks below																			75
	2.25	2215	600.	7	587	1025	6	450	2	25	8.50	118	76	3	450	507	11.50	682	330	7	770	31
½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10⅜"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10⅜"		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
	.89				.38	.63	5			Leased 202		.36	.13			.09			.26			
	2										1				2	1		2	1	1	1	1
	41	29	4	10	11	10	8	6	5	12	6	9	7	2	6	4	7	8	8	12	22	55
	1	1				1																
							1	1													1	
	2	4				1	2			2			2									8
		2		1			1		1			1										2
						1	1		1		1								1	1	2	1
00	600,000	297,000	800,000	200,000	47,924.00		100,000	41,035	34,500	13,100	80,000	500,000		250,000	50,000	30,563.86	100,000	77,500	150,000	150,000	150,000	1,021,999
						100,000	100,000	30,880				234,000					100,000				50,000	1,265,332
00	600,000	140,000	240,000	100,000		150,000						850,000	115,000	35,000	100,000		91,200	60,000	285,000	125,000	200,000	2,044,972
24.11						26,231.01			8,989.56	17,000	80,018	500,000				5,439.07	50,000		17,483.01	46,428.89	46,575.43	150,058
4.11	1,200,000	437,000	1,040,000	300,000	47,934.00	276,231.01	200,000	71,915	63,489.56	30,100	160,018	2,084,000		285,000	150,000	76,003.66	341,200	137,500	452,483.01	321,428.89	446,575.43	4,482,361
68	46,153.85	18,876.80	52,000	42,857.14		25,390.[illegible]	30,769.[illegible]	15,981	31,744.78	12,040	18,832.79	171,381.58	14,817.10	95,000	33,333.33	14,729.44	29,669.56	20,161.29	•	45,918.41	57,996.[illegible]	97,442.03
	971,377.63	452,603.01				285,617.[illegible]	199,[illegible]	37,362.64	58,374.27	94,991.65	107,522.49	2,089,162.14	125,119.10	96,950.70	78,227.78		320,000	90,000.00	308,744.50	200,029.65	450,229.48	
	37,360.68	19,550.88				26,251.58	30,704.40	19,413.92	29,181.15	17,209.32	12,649.41	171,806.10	16,186.77	32,326.94	17,385.95		27,826.09	13,196.45		28,575.90	58,471.36	
35	75,425.35	71,205.29	3,399.60	25,000.00	26,478.04	9,668.[illegible]	13,204.13	15,695.10	7,225.86	23,210.16	17,248.22	24,409.15	23,817.63	4,334.66	18,969.31	17,007.21	19,381.65	18,799.55	24,319.50	11,335.13	27,686.15	373,099.01
	8,790.50		6.40				5,961.03	3,305.03											1,541.53		625.09	18,471.62
		513.05					250.00	688.00		608.92							584.28					4,480.00
	17,132.75	11,975.65					750.22	3,750.49	2,703.35	329.45		6,740.80	2,307.01				2,330.25			3,011.96	9,010.35	1,250.00
	101,348.10	83,693.99	3,406.00				20,165.35	26,139.80	9,929.21	24,148.53		31,149.95	24,048.34				22,296.18		25,861.50	14,367.09	37,321.59	393,300.63
49	7,870.64	4,590.80		12,125.00	4,310.23	2,048.55	1,894.75	771.45	803.00	1,084.56	1,545.26	1,407.07	4,070.06	229.22	1,691.57	324.81	655.07	1,554.46	280.14			23,001.39
08	9,414.25	22,739.58	766.00	850.00	3,100.01	3,088.61	6,802.94	393.81	9,228.53	1,763.54	5,931.56	9,653.29	5,605.01	6,071.74	831.64	2,415.28	6,163.27	1,019.88	123.96	4,742.10	7,453.82	32,029.92
44	36,556.18	25,126.04	4,841.06	2,700.00	8,866.46	4,376.67	11,769.66	18,446.73	3,372.41	16,379.5	9,213.04	14,626.46	6,818.32	11,599.01	7,671.85	9,231.01	9,037.75	8,339.01	23,535.81	7,891.92	20,051.65	217,461.08
01	53,841.07	52,456.42	5,607.06	15,675.00	16,276.90	9,513.83	20,467.35	19,611.99	13,403.94	19,227.25	16,689.64	21,686.77	16,493.39	17,899.20	10,195.00	11,971.16	15,856.09	10,962.85	23,939.91	12,634.02	28,249.64	272,492.39
34	47,507.03	31,237.57	2,201.06	9,325.00	10,201.16	174.27	301.97	6,521.53	3,474.73	4,971.28	558.56	5,463.18	7,554.95	13,565.31	5,772.25	5,086.65	6,440.09	7,836.76	1,921.59	1,733.07	9,071.95	120,808.24
4	308,449	447,468	13,200		167,269	68,335	181,414	82,632	73,060	94,180	157,438	115,597	108,030	27,905	139,020	172,428	111,456	94,298	12,200	66,456	96,011	1,659,163
	7,640						11,683															45,639
	316,089						493,091															1,704,802
7	346,560	1,720,377	17,000	550,000	498,507	197,700	294,436	465,175	180,647	548,000	416,854	626,492	509,195	69,893	349,672	425,194	272,214	252,079		318,430	707,824	7,364,289
	38,200						25,236															6,158
5	2177	4.14	20	455	5.31	4.9	4.55	4.2	4	4.23	4.11	3.0	4.68	6.2	5.43	4	7.12	7.46		3.56	3.9	5.06
	2301						2362															3
9	3206	18.7	258		1583	1418	1044	3.7	1359	256	1095	2695	2226	1553	1364	986	20	1994	2198	2162	3887	2307
5	1703	11.72	12.47		9.73	13.93	1060	23.73	18.35	204	1006	2222	15.27	64.14	7.33	6.94	14.23	11.63	196.23	19.01	29.42	15.98
	1.1	3.84	1.29		2.98	2.89	1.6	5.63	2.47	5.81	2.64	5.42	4.71	2.5	2.52	2.47	2.44	2.67		4.79	7.38	4.44
	5						2.16															1.35
%	53.12%	62.67%	164.62%	62.7%	61.47%	98.21%	101.5%	74.18%	135%	79.62%	96.76%	82.43%	68.587%	41.29%	53.75%	70.39%	71.12%	58.31%	92.52%	87.94%	75.69%	69.28%
	Steam & Water Power	Steam Power	Power Hired From Bradford Rl'wy	Water Power	Steam Power Rented	Water Power Rented From Chaudiere	Steam and Water Power	Water Power Hired	Steam Power	Power Rented From Berlin Lighting Com'rs	Steam Power	Steam Power First Year of Operation	Steam & Water Power	Water Power Rented From Kootenay Power Co'y	Power Rented — Niagara, St Catharines and Toronto Rlwy Co	Steam Power	Steam Power	Water Power	Water Power	Steam Power	Steam Power Hired from Kingston	Steam Power & Water Power

stop the engine, take out the brasses, clean the pin with a scraper or smooth file (never use emery cloth or sand paper), clean out the oil holes and passage-ways If only a little babbitt has run out of the brasses, scra[...] them down to a bearing surface, using a paste c[...] pound of red-lead and oil, smeared thinly ov[...] bearing surface of the pin. By placing the br[...] you are scraping on the pin, after the pi[...] red-leaded, and moving it around a little, [...] out the high places to scrape down, for [...]

oil [...] and get the oil down to the pin, by the sides [...]ds of the brasses, until the pin begins to cool [...]r that you are satisfied that you have gotten oil [...]veen the brasses and pin ; then shut the engine [...]own completely and proceed to scrape the brasses as [...]bove stated.

In either of the above cases, if the babbitt has not started and the engineer discovers that the pin is beginning to cool off, after he has applied the oil freely, he may fill up his oil cups and speed up the engine to full speed and go ahead with perfect safety.

CANADIAN STREET RAILWAY ASSOCIATION.

Representatives from the leading street railway companies in Canada met at the Windsor Hotel, Montreal, on December 20th last and decided to organize an association. A preliminary meeting had been held some time previous at which a committee was appointed to draft a constitution. This constitution was formally adopted at the organization meeting. It provides that the name of the organization shall be the Canadian Street Railway Association, and that its offices shall be at the place where the secretary-treasurer resides. According to the constitution, the object of the association shall be the acquisition of experimental, statistical and scientific knowledge relating to the construction, equipment and operation of street railways and the diffusion of this knowledge among the members of the association with a view to increasing the accommodation of passengers, improving the service and reducing its cost, and the encouragement of cordial and freindly relations between the roads and the public. The members of the association shall be the street railway companies in the Dominion of Canada, each member to be entitled to one vote by a delegation presenting proper credentials.

MR W. G ROSS,
President Canadian Street Railway Association.

The election of officers took place on the second day, when the following were appointed:

President, W. G. Ross, managing director Montreal Street Railway.

Vice-president, W. H. Moore, assistant to the president of the Toronto Street Railway.

Secretary-treasurer, Allan Royce, vice-president of the Toronto Suburban Railway.

Executive committee—C. E. A. Carr, general manager London Railway; E. A. Evans, manager Quebec Railway; D. McDonald, manager Montreal Street Railway.

Attorney, Col. H. H. McLean, K. C., director St John Railway, St. John, N B.

The following delegates were present at the meeting: W. G. Ross, managing director Montreal Street Railway; Duncan McDonald, general manager Montreal Street Railway; R. J. Fleming, general manager Toronto Street Railway; W. H. Moore, assistant to president of Toronto Street Railway; C. E. A. Carr, general manager London Street Railway; Allan Royce, vice-president Toronto Suburban Railway; E.A. Evans; manager Quebec Railway, Light & Power Company; W. Z. Earle, manager St. John Railway; Colonel H. H. McLean and M. Neilson, of the St. John Street Railway; Dr. S.R. Ickes, treasurer Grand Valley Railway, Brantford; Elmer M. White, cashier Hartford Street Railway, Hartford, Conn.; W. B. Brockway, acting secretary treasurer of the Street Railway Accountants' Association of America, Yonkers, N. Y.; also the following officials of the Montreal Street Railway: L. Trudeau, superintendent; M. Grayburn, master mechanic; R. M. Hannaford, chief engineer; D. E. Blair, superintendent of rolling stock; Patrick Dube, secretary, and H. E. Smith, accountant.

Two papers were read at the inaugural meeting, one by Mr. Duncan McDonald dealing with the relief of traffic during congested hours, and the other by Mr. E. A. Evans referring to the carrying of freight on suburban roads.

NEW STREET RAILWAY MANAGER.

Within the past month Mr. E. H. Keating has tendered his resignation as manager of the Toronto Street Railway and has been succeeded by Mr. R. J. Fleming, who for some years has been Commissioner of Assessment and Property for Toronto. The salary attached to Mr. Fleming's new position is stated to be $10,000 per year.

Mr. Fleming was born in Toronto on November 23, 1854. After receiving a business education, he entered into partnership with Mr. T. W. Elliott in the coal and wood business, subsequently turning his attention to real estate. He was appointed Assessment Commissioner for the City on August 5, 1897.

MR. R. J. FLEMING,
Manager Toronto Street Railway Company.

In municipal life Mr. Fleming has been prominent since 1886, when he was elected as Alderman for St. David's Ward, which he served for four years. In January, 1892, he was elected Mayor of Toronto, defeating Mr. E. B. Osler, M.P., and repeating his success in the following year with Mr. E. E. Sheppard as his opponent. In 1894 and 1895 he was unsuccessful,

but in 1897 he again obtained the confidence of the citizens, being elected by 1,800 votes. During his municipal career he fought for and obtained many important reforms in the face of strong opposition, and as Commissioner of Assessment and Property he did yeoman service for the city.

The Toronto Railway are to be congratulated upon securing Mr. Fleming as their manager. His exceptional ability as a business man is admitted on all sides. He is a most vigorous administrator, with a great capacity for work, and as an executive officer has few equals. He is affable, with a pleasing personality.

TORONTO BRANCH A. I. E. E.

The thirteenth regular meeting of the Toronto Branch of the American Institute of Electrical Engineers was held in the Engineers' club rooms, 96 King street west, on Friday evening, January 13th. The subject for discussion was "The Relative Advantages of a 250-500 Volt Three-wire Continuous Current Distribution for the Business Districts of Large Cities," which was introduced by Mr. R. G. Black. For the purpose of comparison and discussion, Mr. Black assumed an ideal condition, namely, a uniformly loaded district. He referred briefly, first, to the different alternating current systems, and, secondly, to the direct current systems, and concluded by advocating the use of the 250-500 volt direct current system. This method of distribution, he said, had been adopted in England and in some of the leading cities of the Unitea States and was giving splendid satisfaction, one of the main advantages being that it permitted the use of storage batteries. An objection could be raised on the ground of the lower efficiency and cost of the 250-volt lamp as compared with the 110-volt lamp, but he believed the manufacturers could soon raise the efficiency and reduce the cost of the higher voltage lamp. That its first cost was greater was largely due to the small demand for high voltage lamps in the past.

An interesting discussion followed Mr. Black's remarks. Mr. C. H. Wright questioned the efficiency of such a system. While the increase of voltage would undoubtedly cut down the cost of copper, it might not satisfy the customer, as the supply of motors from lighting mains would cause excessive fluctuation in the lamp voltage. Mr. W. A. Johnson spoke in favor of the direct current system, especially when the advantages of operating storage batteries were considered. He believed there were many advantages in reaching the lamp direct from the machine, be that machine the generator, the rotary, or the storage battery.

Mr. H. A. Moore said that alternating current plants had been installed in many cities and towns where they were not suitable, and that engineers when estimating on alternating systems in many instances did not appreciate the large investment necessary in secondary mains, transformers, etc., and the losses incidental to transformation and secondary transmission. The alternating current system had been carried too far ; for distribution in the business districts of cities he strongly favored the direct current system. He had in many instances recommended the raising of two-wire 125-volt systems to two-wire 250-volts, and the results had been satisfactory. A 250-volt system was in successful operation in Berlin, Ont.

Messrs. MacKeen, Aitken, Walker, Albert, and others took part in the discussion, which seemed to suggest the more general adoption of the direct current for city distribution within defined areas in the near ture.

PUBLICATIONS.

One of the handsomest calendars received by the ELECTRICAL NEWS bears the compliments of the National Carbon Company, of Cleveland, Ohio. It is a combined calendar and moonlight schedule.

"Trucks for Motor Cars" is the title of the latest bulletin received from the Canadian General Electric Company, who recently acquired the sole right in Canada to manufacture and sell Curtis trucks.

The Rhodes Electrical Manufacturing Company, 70 Bishopsgate St. Within, London, England, have sent us one of their new lists of R.E. type motors, giving particulars of the output of their different frames at various speeds, also prices and approximate shipping measurements.

Bulletin No. 1, issued by the I. P. Morris Company, of Philadelphia, contains some excellent illustrations of turbine machinery installed in the plants of the Niagara Falls Power Company, the Canadian Niagara Power Company and the Shawinigan Water & Power Company. This company are prepared to install complete steam or hydraulic plants.

The Christmas Greeting and January Calendar of the Pittsburgh Transformer Company was one of the nicest bits of holiday printing which reached this office. The company advise that they expect to make the Pretty Girl Calendars for 1905 even more attractive than they have been during the past two years. Any electric light or power company not receiving them will be added to the mailing list upon request.

The book entitled "Petrol Motors and Motor Cars," by T. H. White, A M.I.M.E., and published by Longmans, Green & Company, 39 Paternoster Row, London, England, has been written largely from the designer's point of view and is intended to provide designers and draughtsmen with reliable formulæ and information, in a readily accessible form, on the subject of internal combustion engines. The price of the book is 4s. 6d.

The most complete and useful diary for electrical people which has yet come to our notice is that bearing the compliments of the Westinghouse Electric & Manufacturing Company. Besides its convenient arrangement as a diary, it includes about 40 pages of valuable engineering information which cannot fail to prove of great assistance to all persons engaged in engineering. It is neatly bound in leather.

Two catalogues recently received from Messrs. J. H. Holmes & Company, Newcastle-on-Tyne, England, are of interest. They refer to the Holmes-Page patent switches, of which they are the sole patentees and manufacturers, and their recording voltmeters and ammeters. Their switches have high conductivity, superior finish, quick and wide break and self-adjusting contacts and have an unusually large surface area in proportion to the current to be carried. Their instruments possess features of novelty which distinguish them from the ordinary type of recorder at present in general use. The difficulty of driving a continuous band of paper has been overcome by the use of a serrated driving wheel acting on the centre of the paper band.

PERSONAL.

Mr. Ormond Higman, jr., B.Sc., has been appointed superintendent of the Berlin gas and electric lighting plants, Berlin, Ont.

It is announced that King Edward has conferred a knighthood upon Prof. Joseph Wilson Swan, president of the Faraday Society, London, England, and inventor of the incandescent electric lamp bearing his name.

Mr. Cecil B. Smith recently tendered his resignation as resident engineer of the Canadian Niagara Power Company and has again established himself as a consulting and constructing engineer at 36 Toronto street, Toronto. He has been succeeded by Mr. A. H. VanClive.

Mr. George White-Fraser, who is well known to the electrical fraternity in Eastern Canada, and who has been in the Yukon district for some years, has, we understand, been given the electrical engineering on one of the Government railways to be built in the northern region.

Mr. William Thompson, M.E., recently manager of the Velvet-Portland and Rossland-Kootenay mines, of Rossland, B. C., has gone to Mexico to take charge of the interests of the Waterson Gold Mines, Limited, at Ocampa, but remains as consulting engineer with both Rossland companies. Before his departure he was presented by the Rossland Club with a casket of silverware.

CANADIAN

Electrical News

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SUBSCRIPTIONS.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

British Standardization. Not many years ago a fairly large manufacturer of electrical apparatus in the United States built up for himself a very comfortable export trade, his complete foreign shipments going almost entirely to England. As time passed, he established an agency in the Old Country, and this step led to a very material increase in his business. But there was one feature of the arrangement which bothered him. His staff of designers had to be greatly increased. To a certain gentleman he confided his trouble, and in explanation, took him out to the testing department. "Look," he said, "at that twenty horsepower motor—wound for 165 volts. Here is another one—92 volts. And last week we shipped a large machine that was wound for 345 volts. What do you think of that? I write my agent that if he can secure orders at my standard voltages of 110, 220 and 500, the price of the machines will be reduced very greatly, and he replies, 'but you know, my customers do not want the voltages that you mention—their generators are not wound for them.'" There, in a nutshell, we have the reason why the electrical business in the Western Hemisphere has made such enormous strides—everything has been built on adopted standards, and the cost of manufacture has accordingly been lowered. But in England, when a plant was to be installed, the size of the generator was specified, and the manufacturer built a machine for an approximate voltage, which, should it operate better at an increased or decreased pressure, was rated accordingly. Hence, no two plants used motors and lamps of the same potential—each had to have its supplies specially made. Before us now, however, we have a copy of the interim report issued by the British Standardization Committee, and note with great satisfaction that the absurdity of the above mentioned practice has been realized, and is about to be remedied. The standards coincide to a great extent with those adopted on the American Continent, the material difference being that a frequency, for alternating current work, of 50 cycles per second has been decided upon, against 60 cycles as used here. This is considered the standard frequency, while a secondary standard of 25 cycles has also been incorporated. The interim report makes interesting reading, and we look for the complete document with pleasant anticipation.

Current Theft. In our last issue we referred briefly to the arrangement adopted by the Montreal Light, Heat & Power Company to counteract the desire of some members of the public at large to obtain something for nothing; in this particular case the something being electric current. That meters are tampered with, and thus made to register a lower number of watts than actually passes through them, is a well known fact, but so far few, if any, schemes have been devised to properly and effectively combat this evil practice. No matter what the plan may be, there is always the risk of making a mistake, and the result of such mistake is always more or less serious in character from the view point of the electric company. A lost law-suit, or a false arrest, will, where the defendant has sufficient backbone, result in a counter-suit, to say nothing of the unfavorable light in which the supplying company is placed. This latter point is probably the one which appeals to the central station manager with greatest

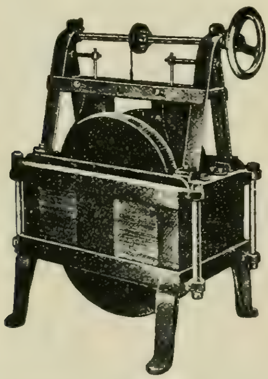
force, for friendly relations with the public is his chief desire, the success of the company hinging directly on this condition. The Dominion Government has done all in its power to protect the central station company from current theft ; in illustration of this, we quote from the Electric Light Inspection Act of 1894 :—"Every person who knowingly repairs or alters, or causes to be repaired or altered, or knowingly tampers with or does any other act in relation to any stamped meter, so as to cause such meter to register wrongly, or who prevents, or refuses lawful access to any meter in his possession or control, or obstructs or hinders any examination or testing authorized by this Act, shall incur a penalty not exceeding one hundred dollars and not less than fifty dollars, and shall pay the fees for removing and testing, and the expense of purchasing and fixing a new meter : Provided that the payment of any such penalty as aforesaid shall not exempt the person paying it from liability to indictment or other proceeding to which he would otherwise be liable, or deprive any other person of the right to recover damages against such person for any loss or injury sustained by such act or default." It is upon this clause that the Montreal Light, Heat & Power Company base their system, for as their charter gives them the right to impose fines in cases where theft of current is detected, the guilty customer, rather than face the court, pays the fine, and, as it were, is given a new start. The meter inspectors keep a close count of the lamps or motors in each building, and knowing, in a general way, the probable current consumption, a check is thus made, and in the event of a deficit, an investigation results. As before noted, great care and diplomacy are needed in carrying out such a scheme, but from reliable sources there comes to us advice that so far, in Montreal, the idea has been very successful.

Real Electric Fires.

From time to time comment has been made in these columns on the subject of fires of unknown origin, which have been charged, without rhyme or reason, to the electric equipment of the building destroyed. In almost every instance these remarks have followed closely upon the receipt of information through the medium of either the lay press or the insurance people, and have invariably been caused by the absurdly unfair light in which the electrical public has has been placed. In our issues of last February and last December, we called attention to the matter, and having taken a definite stand, shall continue to do so until the unjust practice is stamped out. As admitted in our preceding number, a certain percentage of these fires can properly be laid at the door of electricity ; but it is doubtful whether in such cases the real cause of the fire is understood. Defective or damaged insulation is one cause ; the old style open fuse-block is another ; and as a third we have the ordinary incandescent lamp—not broken, or in the act of breaking, but intact. It is with this last risk that we intend to deal in this number, for it seems to be the general opinion of even electrical men that the incandescent lamp gives out very little heat, and that its fire producing tendencies are therefore negligible. The heat from the filment of a lamp with a good vacuum reaches the glass but slowly, and consequently the radiation is usually sufficient to keep the external temperature down to a fairly low point ; on the other hand, when the process of exhausting has not been properly carried out, the lamp soon gets to a point which will not permit handling without a glove. Even in the case of a good lamp, when the radiation is hindered in any way, such as by a surrounding medium, the temperature will rise with great rapidity, which puts the good lamp on a par with the poor one, so far as fire risk is concerned. Numerous tests have been made to ascertain the action of burning lamps on materials of various description, and reference to some of them will no doubt be found of interest. In all cases the lamps used were picked at random, no attempt being made to select either very good or very poor lamps, and the results should lead to the use of greater caution when putting up decorations in connection with lights. In one case, where a lighted lamp rested against a vertically placed white pine board, a spot, about an inch in diameter, and of a light brown color, appeared after about four hours. When a strip of well-seasoned, varnished oak was substituted for the pine, the varnish became blistered in three minutes, and blackened in about fifteen. The wood near the point of contact had the appearance of being charred, but was not ignited. With a lamp incased in two thicknesses of muslin, the latter became scorched in one minute, in three minutes gave off smoke, and at the end of six minutes, when the muslin cover was removed and fresh air reached its interior, it burst into flame. When a lamp was laid on inflammable material, the action seemed more rapid, due, no doubt, to the pressure exerted by the weight of the lamp. A newspaper was, in this way, carbonized in three minutes, and ignited in forty-five. When a 16 candlepower lamp was immersed in half a pint of water, the latter boiled within an hour. Again, with a lamp buried in cotton wool, the wool soon scorched and ultimately burst into flame. A lamp in contact with celluloid fired it in less than five minutes. Another risk is to be found in connection with flexible cord. Cases are on record where short-circuits developed in the drop cords of lamps which were turned off, and although the fuses in the circuits blew instantly, the heat of the momentary arc was sufficient to ignite the insulation of the cord. In one instance the drop, being in a cotton mill, was saturated with oil and covered with lint, and a serious fire quickly developed. There are numerons other cases of similar nature, which could be cited, but their bringing forward is rather beyond the scope of the present discussion. It unquestionably produces a pleasing effect to drape lamps with colored hangings, and to carry out a scheme of decoration conceived along such lines ; and there is no reason at all why this should not be done, always provided that possible fire risks be borne in mind, and the work carried out in a common sense way. It would be a difficult matter to state with accuracy how much the general risk, with things even as they are, has been lowered by the advent of the incandescent lamp, but we are absolutely certain that this lowering has been very great, and that when fires occur, they can be directly charged to gross carelessness. The incandescent lamp, as it stands to-day, cannot be equalled by gas, or coal oil, or candle, or any form of artificial illumination, from the viewpoint of safety and convenience. That it has its risks we are free to admit, but when doing so, to be conscientious, we must state positively that compared to any type of lamp using an open flame, the risk of the incandescent is so infinitesimal as to be unworthy of consideration.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Transformer for Thawing Water Pipes.—In order to meet the demand for a special type of transformer suitable for thawing out broken water pipes, the General Electric Company, of Schenectady, N. Y., have placed upon the market a distinctive style of apparatus, which is shown in the accompanying illustration. The outfit has been designed to withstand rough handling and outdoor service. It is compact and, at the same time, all parts are accessible. Adjdstments over wide ranges of both secondary voltage and current are readily made, and the outfit is simple to handle, portable and comparatively inexpensive. The transformer is designed to operate on circuits varying from 2,000 to 2,300 volts, sixty cycles, and its secondary voltage and current may be readily adjusted from zero to seventy-five volts and zero to 400 amperes by means of an adjustable cord or flux shunt controlled by a handwheel and locking devcie. The outfit complete, including transformer, switches, cover and meter,



TRANSFORMER FOR THAWING WATER PIPES.

weighs approximately 1,200 pounds. It is mounted on four broard, flanged wheels, to permit its being quickly loaded on a wagon bed or sleigh. The space occupied by the transformer is about twenty by thirty inches, with a height of thirty-six inches.

New Type of Oil Fuse.—Exhaustive tests were recently carried out at the works of the Lahmeier Company, Frankfort-on-the-Main, Germany, with a view to determining a suitable type of high-voltage fuse. The first attempts were made with a fuse submerged in oil, which gave satisfactory results up to tensions of 10,000 volts; but the explosion caused by the melting of the fuse was considerable and tended to scatter the oil. A satisfactory fuse of this type requires such a large volume of oil as to make it commercially impracticable. It was also found that the cooling effect of the oil on the fuse made the latter unreliable. It was, therefore, decided to try a device in which the fuse proper was not submerged in oil, but in which oil was used to extinguish the arc after it had been formed. The device consists of a glass cylinder with terminals at the top and bottom. The fuse proper is placed within an inverted cup of insulating material. This cup is closed at the top and open below, and is placed partially submerged in the oil, though the latter can not come in contact with the fuse. Contact is made with the fuse by a clamp at the top, with two flexible copper wires attached to its lower extremity, and passing down to the socket at the bottom of the glass tube. There is also a spiral spring attached to the lower end of the fuse. When the fuse is melted, the spring draws it down under the oil. At the same time, the vapors are forced out at the bottom of the cup through the oil. This cools them and extinguishes the arc. This construction is found to give satisfactory results. A circuit may be fused so that it will carry its normal load indefinitely. It will carry continuously an intermittent overload of fifty per cent. It will carry an overload of eighty per cent. for five minutes, and melt in less than two minutes if the load be doubled.

Westinghouse Oil Circuit Breakers.—The Westinghouse Electric & Manufacturing Company have begun the active sale of a new automatic oil circuit breaker of especial merit, adapted to the most modern system of distant control and designed for voltages from 3,300 to 25,000. The circuit-breaker is made in single-pole units, each being mounted apart from the switchboard in a brick or concrete compartment. Two, three and four-pole combinations are made by placing the units side by side. The base of each unit is of treated soapstone and holds two heavy porcelain insulators which carry the stationary contacts and the connection to the external circuit. The movable contacts are at the ends of a U-shaped metal casting fastened at the center to a rod of treated wood, which is moved up and down by the operating mechanism in closing or opening the circuit. The final arc on breaking the circuit is taken by an arcing tip which may easily be replaced.

A Novel Synchronous Converter.—An interesting method of connecting in concatenation an induction motor with a synchronous motor or rotary converter, forms the substance of a patent issued October 18, 1904, to O. S. Bragstad and J. L. La Cour. The frequency of the current in the secondary of an induction motor varies directly with the slip, and at one-half synchronism it has a value equal to one-half of the circuit frequency. By driving the moving member of a synchronous motor mechanically with the rotor of an induction motor and connecting the secondary windings of the induction motor to the armature of the synchronous machine, the set will synchronize at one-half speed. The inventors propose to use as synchronous motor a rotary converter which can deliver direct current to an external load and to its own field windings. This arrangement allows the converter to be operated at one-half the circuit frequency, which condition of operation is conducive to improved commutation as compared with direct transformer connection to the supply lines, while the machine may readily be placed in use from the alternating-current side. The primary of the induction motor may be wound for the high line e.m.f., thus eliminating the need of additional transformers.

In comparison with an induction motor-driven, direct-current generator set, the combination is much less expensive, due to the fact that the motor here required need be of but one-half the capacity of the load, since only this amount of its energy is delivered mechanically, the remainder being given off through transformer action, and also to the fact that a synchronous converter is more economical in material than a direct-current generator of the same output.

Phase Transformation. — Alexander D. Lunt, of Schenectady, N. Y., has devised a method of transforming three-phase current into 12-phase current, or the reverse, which should be useful in connection with rotary converters in which the armature heating is less the greater number of phases there are on the alternating-current side of the machine. In practice Mr. Lunt makes use of three transformers, each of which is provided with one winding connected to the three-phase system and three other windings connected to the 12-phase system. In all these are nine windings connected to the twelve-phase system, and these windings are so inter-related that their electromotive forces may be represented by a double delta superposed upon a double Y. The phase transformation is performed, preferably, by a set of transformers having primary windings differing in number from the secondary windings.

STATEMENT OF FACT.

The only true measure of the normal capacity of a properly designed generator is the current it will develop safely under short circuit with normal (fully excited) field within a (stated) temperature for a given period of time, the maximum capacity being the current at safe temperature under fully saturated field, short circuit to be applied when the generator is giving out its standard voltage, and the same test should be made on all direct current motors and synchronous alternating motors, by operating them as generators.

Purchasers of electrical machines should insist on these requirements if they want an absolute test. W. A. JOHNSON.

Toronto, Can., Dec. 8th, 1904.

TRADE NOTES.

The Richmond Conduit & Manufacturing Company, of Toronto, have furnished the ELECTRICAL NEWS with a combination desk calendar and thermometer.

We are indebted to the Canadian Heine Safety Boiler Company, of Toronto, the Stuart Howland Company, electrical supplies, Boston, and the Waterous Engine Works Company, Brantford, Ont., for calendars for the current year.

The Pittsburgh Transformer Company report that a surprising demand for pipe thawing outfits is making itself known. A considerable number of electric light plants have written that they used electric thawing for some little time past, and in every case the work has been successful. In a few instances there was no profit in the work on account of the fact that the makeshift appliances available rendered the job slow and expensive. The thawing outfit made by the Pittsburgh Transformer Company is said to be the simplest, cheapest and most rapid working device at present on the market.

The attention of young men is directed to the courses of instruction in technical subjects announced in the advertisement pages of this paper by the International Correspondence School, Scranton, Pa. Full particulars regarding any of these courses will be furnished free of charge to any who may write same mentioning this journal.

The Pittsburgh Transformer Company are desirous of securing the names of companies contemplating the transmission of power or who expect to make extensions to an already existing transmission. To those who will write for these, the company will send full data on their line of power transformers with very complete illustrations of the same. The company state that their improved facilities enable them to put out this line at prices which will interest anybody who is in the market. Extremely substantial construction, graceful design and high electrical efficiency are claimed for these transformers.

Edward E. Cary, of Montclair, N. J., who is well known to the electrical fraternity of Canada, has been appointed representative for the United States and Canada for Joseph Sankey & Sons, Limited, Bilston, England, makers of the "Lohys" brand of non-aging sheets and stampings for all kinds of electrical machines. In a paper by Mr. W. N. Mordey, the great English transformer expert and builder, read before the British Association at Cambridge last year, he refers to the product of this firm in the following words: "The only manufacturers to take up this specification energetically were Messrs. Sankey & Sons, of Bilston, with whom an arrangement was made by which the price paid them was increased or reduced as the iron showed less or more than the standard loss. A few pounds of iron were tested in this way out of each delivery, and the corresponding bonus or penalty ascertained. The result was that within a year large variations of loss had ceased, and it soon became possible to design transformers with something like certainty as to what the magnetizing losses would be. This improvement in quality and regularity which affected the whole industry is mentioned here because it is not generally known how much is due to the efforts of these manufacturers."

BOILER INSURANCE.

The value of boiler insurance is being constantly brought to the attention of steam users by the liberality of the Boiler Insurance Companies. Not only is the manufacturer covered against the hazard of loss resulting from an explosion to his steam plant, buildings and storehouse, mill or factory, but the regular and systematic inspection of his steam plant is a service that, were he not insured, would have to be bought.

The Canadian Casualty and Boiler Insurance Company have set a high standard of boiler inspections. The inspections of this company are regularly and periodically made by competent inspectors under the direction of the company's chief engineer, whose personal attention, we understand, is given to all reports sent out and each visit is fully reported. These reports cover not only the condition of the boiler, but also recommendations as to their efficiency, including suggestions to prolong their life and usefulness. This Department also furnishes general steam engineering advice, covering plans and specifications for boilers, engines, steam heating plants and electric lighting equipment, also the adjustment of engine valves, measurement of power, steam or electric, and the valuation of machinery or any technical information their clients may require.

We are glad to learn that the Canadian Casualty and Boiler Insurance Company have found a place which, in the interest of all steam users, is regarded as prominent on account of the service they render through their Consulting Engineers' Department.

MOONLIGHT SCHEDULE FOR FEBRUARY.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Feb. 1	5 40			12 35
2	5 40	Feb. 2	6 15	12 35
3	5 40	3	6 15	12 35
4	5 40	4	6 15	12 35
5	5 50	5	6 15	12 25
6	5 50	6	6 15	12 25
7	5 50	7	6 15	12 25
8	5 50	8	6 15	12 25
9	5 50	9	6 15	12 25
10	10 00	10	6 15	8 15
11	10 50	11	6 15	7 25
12	11 45	12	6 15	6 30
14	0 45	13	6 15	5 15
15	1 45	14	6 00	4 15
16	2 40	15	6 00	3 20
17	3 30	16	6 00	2 30
18	No Light	17	6 00	
19	" "	18	No Light	
20	6 00	19	" "	2 30
21	6 10	20	8 30	3 35
22	6 10	21	9 45	4 50
23	6 10	22	11 00	6 00
24	6 10	24	0 10	7 05
25	6 10	25	1 15	8 10
26	6 20	26	2 20	9 00
27	6 20	27	3 20	9 55
28	6 20	28	4 15	10 50
		Mar. 1	5 10	
		Total	....	211 50

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All inquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. No. 1.—(a) What is the formula for getting the pull or tractive effort on a pair of static vanes, with a potential difference of from fifty to three hundred volts? (b) What amount of heat would be required to raise a column of mercury one-half inch in diameter and six inches long a distance of one inch?

ANS.—Neither of the above questions can be considered of "general interest," as each applies to theoretical propositions which practically none of our readers will find of value. In this instance, however, we are answering the queries. (a) This question evidently pertains to the method of calculating the pull between the vanes of an absolute electrometer. The instrument consists of two parallel insulated metal plates, the bottom one being fixed, and the top being divided into three sections. Of these three sections, which are in electrical connection, the two outer ones are stationary, and the centre one is hung at the end of a balance-beam. Calling the large stationary plate A, the two outer upper plates BB, and the centre upper plate b, we have the equation :—

$$\frac{1}{F} = \frac{720,000\ p\ d^2}{b\ E^2}$$

where F is the downward pull on b in dynes, p is 3.14159, d is the distance apart of the plates in centimeters, b is the area in square centimeters of the movable plate b, and E is the electromotive force applied to the plates. (b) We presume that in this question, the amount of heat required to *expand* the mercury is desired, and that the column is circular in cross-section. The coefficient of cubical dilatation of mercury in glass is .000158 per degree C., and that of glass (linear dilatation) is .0000086. Therefore, we can assume that the coefficient of the mercury alone is .00015. This holds good between 0°C and 100°C, and we will therefore use this figure. For temperatures above 100°C the coefficient is somewhat higher, but we have no accurate figures at hand. An expansion of one inch equals an increase in volume of one-sixth, and consequently the final temperature of the mercury will be 1111°C. The specific heat of mercury being .033, and the weight of the column referred to being .576 pounds, to produce the expansion mentioned would require 37.95 British Thermal Units. This, of course, assumes that no heat would be lost by radiation, and also assumes that the mercury could be raised to the proper temperature without being vaporized. We would call your attention to the fact that mercury boils at 662°F. and while it has been raised to a temperature of 900°F. in thermometers having compressed nitrogen in the tube, we conclude that it is not possible to devise any means whereby the temperature needed in your question could be reached.

QUES. No. 2.—Do you know of any practical method of locating a grounded armature coil in a three phase revolving field type generator? The ground is such that it is not registered by the ground detector until the voltage comes very near to normal.

ANS.—If you are sure that the ground is in the armature, and not out on the line, nor in the cabling in the power house, the easiest, quickest, and most satisfactory way of locating the fault is by means of burning it out. This is assuming that you have A.C. of both 110 or 220 and 1100 or 2200 volts. Disconnect the leads at the machine running to the switchboard. Take any small transformer and connect the high voltage side to the proper voltage in the power house, and one lead of the low side to the frame of the grounded generator, and the other lead to the winding. In the low potential side of the transformer there should be a double pole switch and a small fuse. Close the switch, and the fuse will probably blow, a flash showing at the point where the armature winding is grounded. This operation may be repeated until the fault is definitely located, care being taken not to burn the insulation too much. If the ground is not indicated in this way, connect the low side of the transformer to its proper voltage, with the switch and small fuse in circuit; connect the high side for 1100 volts, and attach one lead to the frame, and the other to the winding. If the fault is not then located, change the connection to give 2200 volts. If the fuse does not blow and the fault cannot be found, it is no doubt so trifling that it can be passed. We assume that you wish to locate the ground with the idea of making an immediate repair. If the grounded machine is the only one you have, the test may be tried with the exciter, taking care to use a very small fuse. If a magneto will ring through the ground, one section of the winding can be separated at a time and tried, and should it show a ground, then subdivided and tried again, and so on until the fault is localized in the particular coil in which it exists.

QUES. No. 3.—I would be pleased to have your suggestion, and that of any reader of the ELECTRICAL NEWS, as to how I can best apply electrical power to maintain steam in a sixty horsepower return tubular boiler. The device must be such that it may be regulated, and in the event of it being insufficient, fuel may be used to assist. The boiler generally has little work to do, but at any time may have work equal to thirty or forty horsepower for a short period. Alternating current at 550 volts is at hand, which could be transformed to any required voltage. Economy of current is no consideration.

ANS.—In a certain town in the West, where there was unlimited electrical power, and where fuel of any kind could be obtained only at a prohibitive price, an electrically operated boiler has been used with some success for heating purposes. This boiler is about fifteen horsepower capacity, and carries a pressure not exceeding twenty pounds. It is a plain steel shell, having no tubes of any kind, and inside, a vast number of iron wire coils mounted on porcelain insulators. We have communicated with the makers of this boiler, and in their reply they give no information of any kind, practically indicating that they do not wish to undertake the construction of a similar device. So far as we know, the number of watts required by the boiler was very high, probably far above your idea when you say "economy of current is no consideration." It is satisfactory only for the reason given above, namely, that it furnishes heat, where, were it not for this scheme, no heat could be obtained. In any event, we do not think you could get a proper working contrivance in which the electric power could be supplemented by either coal or wood, for the boiler being without tubes, would have a very low economy under these conditions.

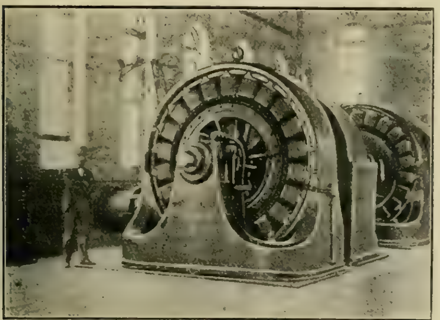
THE INSTALLATION OF A TRANSMISSION PLANT*.

By A Road Engineer.

The Story of an Early Power House, Some Rotary Converter Kinks and Some Telephone Troubles.

It was late in the fall about eight years ago when I arrived at one of the principal cities of the West. An electric transmission system was in course of construction with a power house newly built at the foothills of the mountains some thirteen miles away and a rotary converter sub-station located in the city itself. I had been detailed to superintend the installation of the apparatus for the transmission system, which was a comparatively new piece of work in those days.

I had been through the old student course at Pittsburg and had gotten some little outside experience, just



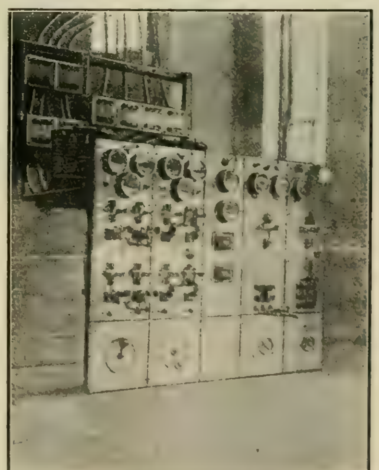
Interior of Power Plant, Showing the 750 K. W. Alternator.

about enough to make me a little nervous over the outcome of my trip. For no matter how long you have been on the road, each new job is found to be different from the others you have done. It is often some engineering feature not foreseen in the laying out of the plant, or some operating condition not duly appreciated, or again it happens that the proper facilities for doing the work are not at hand. Indeed enough uncertainties are always present to arouse in one the liveliest interest and no man can foresee just when he will encounter some problem which will test his metal to the uttermost. And I had a premonition that perhaps this job was mine. I already knew that there were some engineering features about this plant, common enough now-a-days, but unusual enough at that time to arouse my liveliest anticipation.

This particular plant was laid out for three 750 kw. generators, but only two were to be installed. They were 60 cycle three-bearing machines arranged to have an impact water wheel mounted on the shaft just where a pulley would be placed if the machine were to be used with a belt drive. Two exciters were furnished, each mounted with a water wheel similarly to the generators. A switchboard, two banks of two-phase, three-phase transformers for stepping up to 15,000 volts, some high tension bayonet switches and type R lightning arresters completed the power-house equipment. The transmission was thirteen miles and at the receiving end were two 400-kw., 550-volt, 18-pole rotary converters. These converters were the largest that had yet been built for 60 cycles. Indeed few of any size were then in service. The local company had been recently organized and was not yet operating. It had no electrical engineers in its employ and only one employe, a lineman, had ever done any electrical work. The company was to furnish all necessary labor and the manufacturers of the electrical apparatus were to lay out the system and superintend the installation.

The first generator had been shipped some time previous to my arrival and had already been hauled across country from the railroad and was lying at the power house in the mountains, much the worse for its trip. The men who had contracted to do the hauling had not a sufficiently stout wagon to carry the heavy generator weights and the wagon with the armature had broken down, ruining a considerable portion of the bar winding and end connectors. The first thing to be done, therefore, was to determine what material was needed for repairs and write out an order for the local company to send to the manufacturer. In situations such as this, where the work is done many miles from any kind of a shop, it is quite essential that the road man be prepared to work with his own hands as well as to superintend, and if he have a well-equipped tool chest it facilitates the work very much. I had use for mine when that winding came.

The location for the switchboard and the station wiring had been laid out by the manufacturing company, but on arriving at the plant I learned for the first time that a separate building had been provided by the local company for the raising transformers. It was in such a location that the plans for the switchboard and the station wiring would have to be changed. As usual, no provision had been made in the construction of the power house for putting any wiring into it at all. There was, therefore, no difficulty in changing the proposed location, and I gave instructions to the



The Switchboard.

local company for the building of a suitable wiring conduit. This was put in at once.

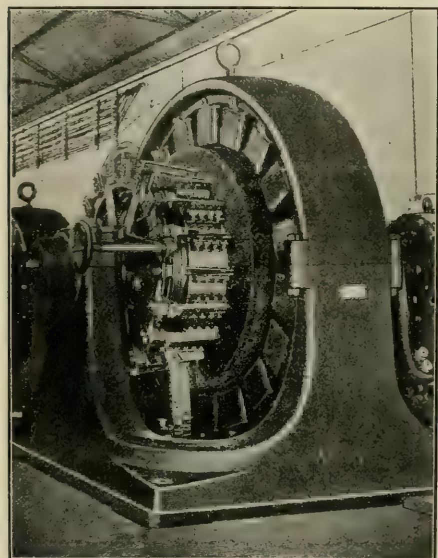
The transformer house had been built without any provision for high tension switches or lightning arresters. It was only after considerable planning and a sacrifice of desirable head room that I arranged to have a second floor built in it, which permitted the installation of the apparatus. It was a very cramped position, but it was absolutely needed.

As the engineer was to stay at the plant until it was

*From the Electric Club Journal, Pittsburg.

put in operation, it was advisable, in order to save time, to assemble the water wheels and their governing mechanism. While this did not prove to be a difficult task, it was an eye-opener. I got some experience in handling machinery which was new to me and a little out of my line.

The rotary converters, on account of the type, naturally required considerable attention and some experimentation to get into satisfactory service. One of the characteristics of these machines, which occasioned special treatment, was the high commutator speed, which greatly increased the influence of surface roughness upon the commutator. The combination of high speed and roughness caused the brushes to vibrate, which resulted in rather poor contact between them and the commutator. Of course sparking took place. If the commutator was neglected, the sparking would accentuate the roughness of the commutator and this increased roughness would further aggravate the



400 K. W. Rotary Converter.

sparking, so that the sparking would increase at an accelerating rate until the machine would finally buck. This with a uniform load, while all other conditions were good. The cause was not fully understood at the time and it was thought to be chiefly in the setting of the brushes. After a short experince with this machine it was discovered that a smoothness sufficient for slow speed commutation might not be sufficient at a high surface velocity. Although the commutator might feel smooth to the finger, if the end of a lead pencil was pressed against the back of the brush, a good deal of vibration might be felt. In overcoming this it was found quite advantageous to support a piece of a grindstone on a properly constructed rest and crowd it against the commutator, while running with the starting motor. This was persisted in until a fresh surface was obtained. After following this up with very fine sand paper, a surface was gotten which caused no perceptible vibration of the brushes.

A further aid to smooth running was obtained by saturating the brushes with cylinder oil. Two sets of brushes were fitted to each machine and while one set was in operation the other was immersed in oil. After receiving the above treatment, a machine would commutate perfectly for a very considerable period of time. After this a few hours' work would be required to put it in shape again.

When first put into commission these rotary converters pumped quite badly and no adjustments of their fields would materially improve them in this respect. After some correspondence with the manufacturing company instructions were sent out to me to bore out the fields for a larger air gap and bevel the pole corners. The boring out of the fields was somewhat of a puzzle at first as the machines were too large to be handled by any machine shop in that territory. After a time a boring bar was located that had been used to bore out the cylinder of a medium sized Corliss engine. This bar was mounted in the bearings of a rotary converter after having been reconstructed to bore a sufficiently large diameter. It was belted to the end of the shaft of the other rotary converter which was carrying the railroad load. This belt was necessarily small and ran at such a low speed that it would not transmit power enough to pull the cutting tool through more than a very fine cut, but by taking a large number of cuts the bore was increased to the required amount. While this was being done the manufacturing company sent out two sets of copper dampers to be tried on the pole pieces. One of these sets consisted of sheets of copper bent to the curvature of the pole face and each made to completely cover one pole face. The edges of each sheet was bent up an inch or so all the way around to secure it to the side of the pole piece.

As soon as the above changes had been made on one machine it was brought up to speed by the starting motor and the field was built up. Before, however, the field attained full strength, the machine commenced to make an ominous noise and slow down. On investigation it was found that the copper facings on the poles had bulged out against the armature and were actually acting as brakes on the armature core. The armature being of the open slot type, its teeth caused the magnetic flux in the air gap to gather in tufts, and as these tufts followed the teeth across the pole faces, they generated such excessive currents in the copper plates that the latter were discolored by heat and pulled out of position by the magnetic action of the induced currents. This difficulty was so great that these dampers could not be used at all. Their action is now well understood and with partially closed slots they make an effective damper. The other set of dampers was made of rectangular bars of copper surrounding the pole pieces near the tips. Their use and the change in air gap and beveling of the pole corners, resulted in decreasing the pumping to an unobjectionable amount.

Before the above difficulties had been overcome, and, in fact, immediately after the railroad had been transferred from the old steam plant to the rotary converters, the local telephone company and a considerable number of its patrons, whose lines were placed directly above the railway feeders, were much disturbed by a hum in the telephone receivers whenever they were raised from the hooks. In some cases this hum could be heard across a large room, and when the receiver was placed to the ear the noise was very disagreeable. A periodic variation of the sound in synchronism with the pumping of the rotary converters was its most noticeable feature. It did not take the telephone com-

pany long to locate the cause of the disturbance and they then proceeded to make things interesting for me, among other things hinting that steps would be taken to prevent the operation of the sub-station. This looked pretty serious, as the rotary converters were of a new type and anything tending to bring discredit on them would surely affect future business.

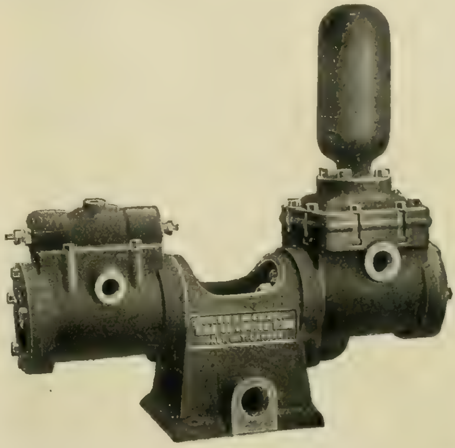
In situations like this it is of advantage to the roadman if in addition to being an engineer he is something of a diplomat. In this instance the roadman was not skilled in this direction, but he did his best to assure the telephone company that his company, to whom the matter had been reported, would do everything in its power to overcome the difficulty, and that a remedy would speedily be found, and then he lay awake at nights trying to think of a remedy, but without much success. Various theories had been advanced by different people to explain the difficulty. One was that the armature teeth, which were large and not very numerous per pole, presented varying amounts of iron to the pole faces, thereby causing slight fluctuations in the total magnetic flux, with corresponding pulsations in the e.m.f. and current. The vibration of the brushes was also thought to be a cause of the trouble, the vibration making the contact resistance a variable one with corresponding variations in the current. The smoothing of the commutator and the lubrication of the brushes described above would have reduced the effect of this cause and the increase in the air gap would have reduced any effect caused by the armature teeth. It was never determined how much, if any, of the trouble came from either of these causes, because the complaints from the telephone company suddenly stopped and no further investigation was made. The telephone company had found that the trouble existed mostly on circuits using a ground or common return and was negligible on an all-metallic circuit properly transposed. They evidently decided that the most satisfactory solution of the problem was the reconstruction of their circuits.

The transmission company had a few telephone troubles of its own. Its circuit from the power house to the sub-station was placed on the same poles as the transmission circuits and it consisted of two insulated wires under one covering. In addition to the braid common to the two, one wire had a braid covering and the other a rubber covering. I never learned just what reasons prevailed in the adoption of this style of construction. It was installed when I arrived and I was called on to operate it for a time. The main difficulty came in getting a sufficient amount of current through the circuit. The talk was very weak at all times. Another and very unique kind of trouble was caused as follows. In the country districts hunters were often out after small birds about the size of meadow larks. These birds frequently lit on the telephone circuit, and when the charge of bird-shot came, one or more of the shot would frequently wedge between the twisted telephone wires and short circuit them. As the wires were seldom cut in two and the insulation was but little frayed these faults were quite difficult for the patrolman to locate. These short circuits prevented the bells from ringing, but did not prevent the transmission of speech over the circuit, so the operatives at every recurrence of this trouble would simply go to the phones at pre-arranged times, lift off the receivers, and commence talking. This circuit was soon reconstructed with separated wires and this trouble ended too.

Some months later I was made superintendent of the power company and had ample opportunity to determine the expediency of various things I had done in getting the plant in operation.

STEAM BOILER FEED PUMP.

On this page we give an illustration of a steam boiler feed pump made by the Goldie & McCulloch Company, Limited, of Galt, Ont. The illustration gives a good general view of the proportions and construction, but the following description will be of interest to users of steam power. The base of the pump is cast hollow, forming a suction chamber to which the suction pipe may be attached on either side. The steam and water cylinders are both attached to this base and both overhang. This arrangement permits the cylinders to be removed for inspection or for repairs. The water cylinder lining, valves and seats, rod



box, glands, nuts, etc., are brass. The piston rods are Tobin bronze or Muntz metal. These metals will neither tarnish nor corrode. All the regular lines of pumps have these in and do not cost extra. The pump cylinders are provided with a removable brass lining that can easily be taken out for reboring or exchange.

The pump is self contained, thus obviating the necessity for a large and expensive foundation. After the pumps are tested at the works they are properly packed and shipped ready to connect at once as soon as they arrive at their destination.

The prospectus of the Chilliwack Power & Light Company, of Chilliwack, B.C., furnishes some particulars regarding the proposed plans of that company. The president is Ald. Thomas Stout, and the secretary-treasurer Charles M. Oliver, both of Rossland. Mr. J. Burtt Morgan, of Chilliwack, is general manager. Messrs. Hermon & Burwell, of Vancouver, are the general engineers, with whom is associated Mr. Wynn Meredith, of Vancouver and San Francisco, as consulting engineers. The authorized capital is $500,000. It is proposed to harness certain waters power on the Chilliwack river for the generation of electrical energy for domestic and industrial purposes and for the operation of an electric railway between Chilliwack and New Westminster. A diversion of a portion of that river will be made at a point about seven miles above the Vedder Crossing and the water conveyed by a flume around the foot of the mountain for a distance of about 1½ miles. This will give a head of about 100 feet. At this point a power-house will be constructed in which two units of 1,000 h.p. each will be installed. The approximate cost of the dam, flume, power plant and transmission lines for the distribution of power throughout the municipality will be in the neighborhood of $125,000. Twenty-five year franchises have been obtained from the municipality of Chilliwack for lighting, power, telegraph and telephone purposes, and for the laying of tracks for tram-lines. The electric railway between Chilliwack and New Westminster will be about 60 miles long, and the engineers estimate that it can be built and equipped for $750,000. Franchises from all the municipalities through which the railway is to pass have not yet been obtained and the work of construction will not be commenced until next spring.

ENGINEERING and MECHANICS

BOILER INSPECTION IN BRITISH COLUMBIA.

The system of inspecting steam boilers which is in vogue in British Columbia has been found to be quite effective, and a steady decrease in the number of accidents is announced. Mr. John Peck, Chief Inspector of Boilers, gives in his last report the following particulars of the work :

I am pleased to be able to report that the work in all the districts has again run very smoothly ; in fact, there is little reason why it should not, as almost all the plants are now in good order, and any work that had to be done to meet the requirements of the Act, in most cases had been done previously ; with the exception, of course, of those plants on which first inspections were made this year.

Last year I reported that we had made 860 complete inspections, leaving 839 boilers on which no inspection had been made. This year we have made 890 complete inspections ; 364 boilers have been inspected for the first time, 199 of these being new boilers. During the year 14 boilers have been taken out of service, leaving 1,489 boilers on our report books. In addition to these, we have located 334 boilers that have not yet been inspected at any time, making a total of 1,823 boilers, leaving at the end of December 933 boilers on which no inspection was made, showing that the present staff are only able to do about one-half the work of the Province.

With respect to the summary of total work done, I may say that the testing of the boiler plates has resulted in nearly 10% of these being rejected, which is about the same as last year's figures. The new boilers installed are almost double the amount of the previous year, and the number built within the Province also doubled. The repairs list shows a decided improvement, being only about one-fifth of the previous year's account. The defects observed, together with those marked "dangerous," show a very material reduction.

Comparison and examination of the summary of total defects of the two years indicate that the engineers are more careful and are paying more attention to their plants, thus keeping them in better shape, so far as their part of the work is concerned.

SUMMARY OF TOTAL WORK DONE IN 1903.

No. of drawings and specifications calculated for new boilers	223
" boiler plates inspected	87
" boiler plates rejected	8
" boilers built under inspection in British Columbia	107
" boilers built under inspection in Eastern Canada	32
" boilers built in Eastern Canada not under inspection	51
" new boilers inspected built in the United States	26
" new boilers inspected built in British Columbia	34
" new boilers inspected (total)	199
" boilers imported from Eastern Canada (second-hand)	4
" boilers imported from United States (second-hand)	12
" boilers unclassified	71
" first inspections	264
" inspections, external and internal	753
" internal inspections only	3
" external inspections only	27
" special inspections after repairs	50
" visits in addition to inspections	600
" boilers subjected to hydrostatic test	812
" boilers on which pressure was reduced	42
" boilers unsafe without extensive repairs	8
" boilers repaired under Inspector's directions	60
" boilers considered unfit for further use	2
" accidents to engines and boilers	20
" accidents resulting in personal injury (not fatal)	4
" investigations	5
" inspections completed	890
Total horse-power of boilers inspected	42,223
Number of defects observed as per summary	1,514
Number of defects considered dangerous	89
Inspection fees earned	$7,729.39
Inspection fees collected	$7,407.61
Miles travelled by the Inspectors	25,764
Letters inward	3,682
Letters outward	6,424
Telegrams inward	79
Telegrams outward	73
Boilers taken out of service	14

SUMMARY OF DEFECTS OBSERVED.

Nature of Defects.	Number.	Dangerous.
Boilers with safety valves inoperative	2	2
" with safety valves overloaded	3	2
" with safety valves defective in construction	44	4
" without pressure gauges	6	2
Pressure gauges inoperative	7	2
" " defective	121	3
Cases of insufficient staying or bracing	26	5
" defective stays	31	1
" broken rivets	65	0
" defective riveting	16	0
" broken stays or braces	6	0
" loose stays or braces	65	5
Boilers damaged by low water	8	4
Defective settings	21	1
Boilers with fractured plates	12	3
" laminated plates	4	2
" burned plates	29	8
" blistered plates	2	0
Cases of sediment on fire sheets	66	5
" internal corrosion	30	0
" scale or incrustation	107	7
" internal grooving	18	0
" external corrosion	45	1
" defective tubes	45	3
" defective feed water arrangement	75	0
" broken feed valves	2	0
Serious leakage around tube ends	24	1
Serious leakage in rivet joints	54	0
Defective blow-off pipes or cocks	56	12
Defective water-gauges	26	1
Broken blow-off pipes or cocks	8	2
Water columns without blow-outs	21	2
Cases of broken test cocks	44	0
Connections to water columns without valves	72	1
Neutral sheets not stayed	40	0
Neutral sheets improperly stayed	6	0
Furnaces out of shape	0	0
Boilers without fusible plugs	102	0
Boilers low at front end	28	0
Cases of serious leakage of fittings	23	0
Number of hand-holes, doors having bolts and dogs burned off	16	0
Defects in engines	5	0
Boilers without hand-holes	7	0
Boilers without stop-valves	15	0
Cases of defective steam pipes	6	0
Unclassified defects	107	10
Total	1,514	89

OIL AS FUEL.

The Pacific Coast Steamship Company, which has lately been experimenting with crude petroleum as fuel for its steamers, has decided that oil cannot displace coal on its vessels. The experiments of the company were made on the steamer Coos Bay, on Puget Sound. Some time ago oil-burning apparatus was installed on the Coos Bay, and it was given a very fair test, with the result that the company has decided to revert to the use of coal.

The specific reasons for the decision against oil are not given by the company. It is, however, stated that in addition to the dislike of the engineering department for oil the passenger traffic officials have made complaint that many people refuse to travel by steamers burning oil as fuel, the travelling public being to a certain extent afraid to patronize vessels carrying oil tanks. While the popular belief that danger lies in the carrying of bulk oil may have been a factor in determining the decision of the Pacific Coast Steamship Company regarding oil, it could scarcely have been the principal cause of its rejection.

Mr. T. L. Roberts, fuel and locomotive inspector for the C.P.R. western lines, has gone to New York to continue a series of experiments which the company is making with the Canmore and Bankhead coal. The results of the experiments made to date have not been announced, but it is learned unofficially tha tthey have been most satisfactory and go to confirm the belief that the deposits of those districts are among the most valuable on the continent for steam purposes. Another valuable point is the ease with which the veins may be worked and accessibility of the mines from the railway.

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POWER DEVELOPMENT AT FORT FRANCES.

The announcement has been made during the past month that the Backus syndicate, of Minneapolis, have awarded the contract for building the dam in connection with the proposed power development on the Rainy river at Fort Frances, Ont., for which they have been given a franchise by the Ontario Government. The contractors for the dam are Messrs. Penniman & McGuire, of Providence, Rhode Island, and it is understood that the work will be commenced not later than March 1st. The syndicate have been given the right to develop the full amount of power, which is estimated at 60,000 horse power. A view of the falls is shown on this page.

ALBERTON FALLS, ON THE RAINY RIVER TO FORT FRANCIS, ONT. TO BE DEVELOPED BY THE BACKUS SYNDICATE.

The International Union of Steam Engineers, in convention recently in Omaha, Nebraska, decided to hold their next annual convention in Toronto.

GAS ENGINES FOR RAILWAY WORK.

A producer gas plant furnishes power for an electric railway running from Pugliano, near Naples, to a point about 325 feet below the actual summit of Vesuvius. The Dowson process is employed, and there are two 100-horse-power gas engines each driving a direct-current dynamo giving 137 amperes at 550 volts, and a storage battery having a 260-ampere power capacity over 1 hour. The dynamos, which are driven at 700 revolutions per minute, can be raised in pressure to 770 volts, it is said, for charging the battery without increasing the number of revolutions. The gas engines, which operate normally at 160 revolutions per minute, have cylinders 20½ inches in diameter and 29.9 inches stroke. About 175 cubic feet of water are required per hour for the gas apparatus and for cooling the engine cylinders.

NIAGARA'S POWER—PAST, PRESENT, PROSPECTIVE.

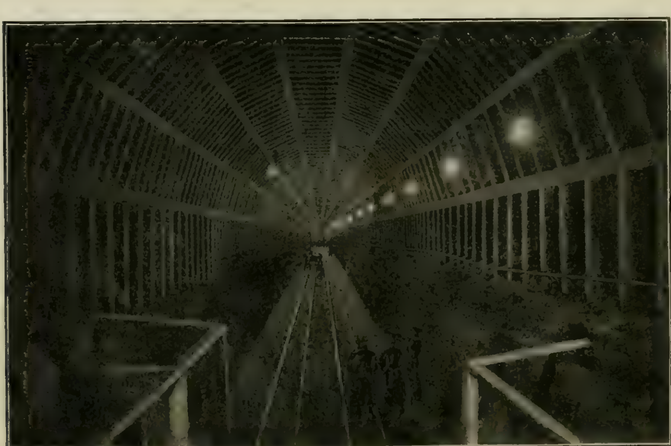
The many interesting features associated with the development of electrical power at Niagara Falls were reviewed at some length in a very able address given by Mr. Frederic Nicholls before the Empire Club at Toronto on January 19th last. As one of the promoters and general manager of the Electrical Development Company, Mr. Nicholls has acquired a very thorough knowledge of the vast engineering works that are under way for the harnessing of the Niagara power, and he was therefore able to present the situation in a most acceptable manner.

After briefly referring to the early geological history of the river and falls, Mr. Nicholls reviewed the efforts of the late Lord Dufferin and others which resulted in the establishment of the Queen Victoria Niagara Falls Park, and the steps subsequently taken to provide for the maintenance of the Park by awarding a franchise for the construction and operation of an electric railway between the Park and Queenston, the annual rental for which was $10,000. In the same year the Commissioners gave to an English syndicate an option of the sole right of using for power purposes the waters of the Niagara river within the park, at an annual rental of $25,000. This option was renewed by the Commissioners from time to time, but Colonel Shaw, who held the option, being unable to interest the necessary English capital, associated with himself Mr. Wm. B. Rankine and others in the United States, and in 1892 the Canadian Niagara Power Company was organized. With the franchise of this company went the obligation to have completed water connections for the development of 25,000 h.p., and have actually ready for use 10,000 developed electrical horse power by the first of May, 1897. The company failed to develop the stipulated amount of power within the time allowed by their franchise and the Commissioners were therefore authorized to lease to others such additional power sites as were available after the final location by the Canadian Power Company of the limits of their concession.

Mr. Nicholls then outlined the agreements subsequently entered into with the Ontario Power Company and the Electrical Development Company of Ontario, and referred to the relation of the various undertakings to the present and prospective flow of the river in the following words:

"I have previously mentioned that the total estimated horse power of the river passing over the Falls is from six to seven million, and a later authority, Mr. James Wilson, Park Superintendent, estimates that, after making liberal deductions, a total of 5,500,000 h. p. electrically can be safely assumed, 90 per cent. of which is at the Canadian or Horse Shoe Fall. When all the companies who are operating both on the Canadian and United States sides of the river have developed their concessions to their maximum output, which of course cannot be for some time to come, only about 78,000 cubic feet out of 223,000 cubic feet per second will be diverted, leaving 144,000 cubic feet plus 25,000 cubic feet (which is taken from the United States side), or a total of 169,000 cubic feet remaining on the Canadian side to perpetuate the scenic effects of the Horse Shoe cataract. Whether this deduction in years to come, of about 23 per cent. of the water passing over

Electrical Development Company—Excavation for Wheel Pit.



Electrical Development Company—Main Tail Race Tunnel, Showing Excavation Completed Ready for Lining of Concrete and Brick.

the brink of the Falls will detract from their granduer can only be estimated, but as a mere spectacle I am inclined to think that a depth of water of say from 12 to 14 feet projecting into the abyss below will be as awe-inspiring as ever."

The special features of each development were then described by Mr. Nicholls. Referring to the work which has been done on the plant of the Electrical Development Company, he said in part:

Electrical Development Company One of the Transmission Towers, Showing Derrick Used in Erection.

"Our development radically differs in many ways from any of the others on either side of the river. A novel feature is that all the works of the company are practically constructed on what was previously the river bed—that is to say, that no encroachment has been made on park territory, but the room required has been wrested from the most turbulent part of the upper rapids at Tempest Point. To accomplish this it was a necessary preliminary to construction to unwater about twelve acres of the river, and the doing of this called for much engineering skill. The contractor having failed, however, to make the dam watertight, our engineering staff subsequently executed an inner dam which secured the desired result.

With the forebay unwatered, work was begun on the headworks. A concrete gathering dam, with granite coping, extending up stream from the lower end of the wheel pit at an angle of thirty degrees, conducts the water to the gates, increasing the available head and stilling the water. This dam is designed to act as a spill-way for its entire length, thus enabling the surface ice to escape before reaching the submerged arches mentioned later. This action is still further increased by having the top of the last sixty feet—at the down stream end—three feet lower than the rest of the dam. The heavy ice will be that brought down from the upper lakes in the early spring. It is not expected to be large in amount, as most of it passes down the river near the centre of its flow. However, ample provision is being made to handle whatever amount may possibly come. The water before reaching the penstocks will have to pass through two rows of submerged masonry arches, separated by a quiet bay equipped with a spill-way at its lower end for passing off such ice as may be in it. Between the second row of arches and the gates lies a second bay equipped with a small spill-way at the end, and with a set of metal gratings in front of each gate. This last bay comes beneath the limits of the power house or generating station, and will consequently be covered.

"Nor was the work preliminary to the excavation of the main tail-race tunnel less devoid of excitement and risk, which at one time amounted to heroism. The main tunnel, which is the largest tunnel in the world, is about 2,000 feet in length by about 33 feet in diameter in the rough, that is to say, before it is lined with cement, concrete, and hard burned brick, which will reduce its area to 26 by 23½ feet. It is constructed 158 feet below the bed of the river, commencing at the end of the wheelpit, and discharging behind the falling waters of the Horse Shoe Fall about 700 feet from the shore. In order to reach this outlet a shaft was sunk at the brink of the Falls to a depth of 150 feet, and a construction tunnel 14 by 7 feet was driven to the point 700 feet distant, where excavation of the main tunnel would be commenced. When about half of the distance had been driven it was decided by Contractor Douglass to excavate an opening for the construction tunnel to the chamber between the face of the cliff and the falling water, for the purpose of dumping the debris into the river and save hoisting it up the shaft.

"The first hole was made near the ceiling of the drift, and immediately dense clouds of spray rushed in through the opening, and water, intercepted by the talus, began to rise in the floor of the tunnel. Powerful pumps were set to work to keep the water down, but the task was beyond them, and the water steadily rose until only a small space remained between it and the roof. If the rock at the mouth of the opening—which acted as a dam—could be removed, the water would immediately run out, but how to remove it was a puzzle. The emergency developed volunteers, and

Electrical Development Company Sub-Station as Used at Each End of High Potential Line.

three were selected for a most dangerous service. A flat-bottomed boat was lowered down the shaft to the end of the flooded tnnnel. It rode so high that it would not clear the roof, and ballast was put in to make it ride lower. The three men, with several boxes of dynamite and a lot of copper wire, then started on their voyage by lying down on their backs and propelling the boat by pushing with hands and feet against the ragged roof. When they reached the opening several hundred feet away, they placed the dynamite, connected the wires, and started on the return journey, the boat sinking under them just as they reached the shaft. The dynamite was exploded, but failed to entirely remove the obstruction, when another and equally daring method was tried.

Main Power House of the Winnipeg Electric Street Railway Company.

"Our chief construction engineer and two men, roped together like Alpine guides, started for the opening along the face of the cliff behind the Falls. At all times the spray was blinding in its intensity, and gusts of wind or compressed air would almost beat them to the ground, but they persevered until success crowned their efforts, and they stood in front of the opening, having ventured such a distance behind the Falls as had never previously been accomplished.

"Here the difficulty was diagnosed, and subsequent trips were taken to place a huge quantity of dynamite where it would do the most good, and on one Saturday near midnight the charge was electrically exploded. Supreme effort met its just reward. I am glad to say the obstruction was removed, and the water ran out of the tunnel, and ever since then there has been no set back of any kind, and the enormous tunnel, which has now been driven its entire length, is as dry and pleasant as this room.

"Apart from its being the largest tunnel ever constructed, there are several novel engineering features connected with it. Instead of commencing directly under the wheel-pit, it starts with two branches, one on either side of the wheel-pit. These join at a point 165 feet beyond the end of the wheel-pit, forming a section 26 feet high and 23½ feet wide, of a horse-shoe form, the object of the water wheels discharging alternately into a branch tunnel on either side instead of into one main tunnel beneath being to enable one half of the power house to be shut down at any time for examination of repairs, a feature unique with this installation. It is estimated that with the complete plant in operation the velocity of the discharged water will be 26 feet per second, and the quantity about 12,000 feet per second. Over the wheel-pit will be the generating station or power house.

"The power generated will be delivered by underground cables to the step-up terminal station of the Toronto & Niagara Power Company, which has been organized to distribute the output of the Electrical Development Company's power house. This terminal station is located on the top of the Niagara embankment above the park, about 1,5co feet from the power house. It will be about 200 feet long by 65 feet wide. The current will be delivered at about 12,000 volts, where it will be raised by the step-up transformers to 60,000 volts for transmission to a similar transformer station at Toronto, where it will be reduced by step-down transformers to the commercial voltage required."

WINNIPEG STREET RAILWAY IMPROVEMENTS.

The Winnipeg Electric Street Railway Company have been making important additions to their buildings and equipment. The illustration on this page of the main power house shows the new addition which was built last summer, the dimensions of which are 110 x 55 feet, with a strong truss roof. A 50-ton crane has been provided for handling the machinery. New boilers, engines and generators have been installed, and it is intended to further increase the plant in the near future. The architect for the new addition was Mr. J. Woodman. The Manitoba Construction Company executed the masonry work, while the iron and steel were supplied by the St. Paul Foundry Company, represented in Winnipeg by Mr. P. J. C. Cox.

New Car Barns of the Winnipeg Electric Street Railway Company.

The second illustration shows the new car barns which the company have built in the north end of the city, and which will remove the necessity of cars running through to the south end of the city every night. These buildings were erected by the company themselves.

THE CONCRETE-STEEL HEADWORKS OF THE ONTARIO POWER COMPANY, NIAGARA FALLS.

The adoption of concrete-steel construction for the headworks of the Ontario Power Company, of Niagara Falls, on the Canadian side of the Niagara River, is a conspicuous instance of the application of this material. The concrete-steel structures for controlling the flow of water to the pipe lines comprise an intake 600 ft. long, a screen house 320 ft. long, and the head block, the last being a mass of reinforced concrete for the entrance gates to the three pipe lines of the ultimate development.

The intake admits water from the river into a so-called outer forebay, from which in turn it passes through screens, housed in the screen house, where a traveling crane is to be provided for handling the screens, and from the screen house into the inner forebay which leads to the head block and thence to the pipe lines. The intake is designed to intercept water flowing along the bed of the river for a distance of some 440 feet from the shore line outward, and to divert surface currents toward the center of the stream so as to dispose of in that way the ice and debris floating in the intercepted current. The screen house is designed to catch sand and other heavy particles carried along the bottom of the outer forebay, in addition to screening such material as succeeds in reaching the outer forebay through the intake.

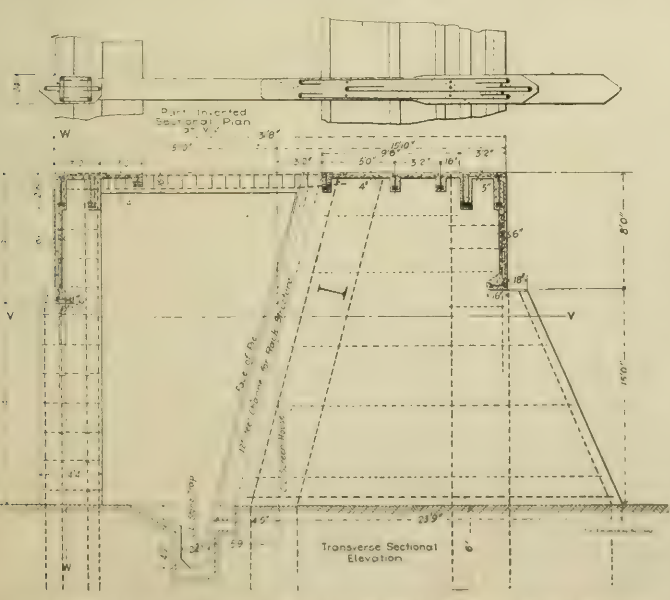
Concrete Steel Framework of the Screen House, Ontario Power Company.

The intake structure, not yet built, is to have a total length of 600 ft., 596 of which lie across the waterway, the intake itself extending outward from the shore at an angle of about 135 degrees with the direction of river flow. It will consist essentially of a pier-supported submerged curtain wall stopped 6 ft. short of the bottom of the excavated approach to the intake, and leaving the wall submerged at low water about 5 ft. The supporting piers will be 4 ft. thick and spaced at distances of 24 ft., center to center, and the curtain wall will be continuous with a horizontal deck forming the operating floor for the intake gates. The piers themselves will be monolithic concrete, but will be continuous, so far as bonding is concerned, with the reinforced deck and curtain. Each opening through the piers will have a total span of 20 ft., and in order to avoid the use of a single gate for that width, a supplementary pier is to be built midway between the main piers to assist the curtain in car ying the thrust upon these gates when they are in their lowered position. This pier will be built independently of the rest of the structure and will be but 12 in. wide.

The screen house is about 320 ft. long and 31 ft. 8 in. wide at the water line. It is carried on columns along the inlet side and on piers along the outlet side, the piers providing for the steel racks or screens. The piers and columns are spaced 20 ft. apart on centers. The columns carry a curtain wall, serving, like that of the intake, for diverting debris and ice toward the river, and also longitudinal beams for the support of the screen-house superstructure. The piers similarly carry, in addition to the screen structure, five lines of longitudinal beams for the screen-house floor, the vertical steel-concrete columns of the superstructure and a curtain wall dipping below the water line on the outflow side of the screen house. The screen-house floor is 5 ft. above the assumed low-water level in the forebays, and the front curtain wall is deep enough to extend 4 ft. below low-water level and the rear curtain wall 3 ft.

The main members of the substructure columns are 1-in. vertical rods tied together with ½-in. rods. The inner group of vertical rods of each column is continued a short distance above the screen house floor, where they are fastened to the upright rods of the reinforcement of the superstructure columns. Of the two beams carried by the substructure columns, one forms part of the curtain wall, and in this and other respects this curtain is quite different from that of the intake. It is but 10 in. thick, as compared with the 21 in. of the intake curtain, but is expanded at its lower edge into a beam, and is furnished with a reinforcement between the beam at the lower edge and that under the level of the screen-house floor with a s stem of 5/16-in. vertical rods placed close to each face. The rear curtain is of the same construction.

The piers are 24 in. thick where they carry the heavier loads, that is, along the rear wall of the screen-house, and are 18 in. thick where they are extended forward for the screen structure. The main members consist of 1-in. rods with ½-in. horizontal tie-rods bent around them. While the space immediately over the screens will be left so that it can be



Cross Section Through Screen House Substructure, Ontario Power Company.

reached from the screen-house, portable flooring will be laid over this part of the building, and for carrying it there are transverse beams extending from each pier to the corresponding substructure column. The sand trap is a longitudinal trench lined with concrete and provided with covers to be removed successively whenever sand is to be discharged from the foot of the screens through the conduit into which the sand trap leads.

The building walls are divided into panels 20 ft. long, corresponding to the spacing of the substructure piers, and the columns at each substructure column and at each pier carry a transverse beam and a longitudinal beam, by which beams the roof is supported. The longitudinal beams each carry the ends of two intermediate transverse beams, so that the transverse roof beams are spaced along the building at distances 6 ft. 8 in., center to center. The superstructure columns are 12 × 15 in. in cross-section, with four vertical 1¼-in. rods as the main reinforcement, and the longitudinal roof beams are 10 in. thick and 24 in. deep, while the transverse roof beams are 8 in. thick and about 22 in. deep. Those of the latter, which are carried directly by the superstructure columns, are slightly heavier than those intermediate, the group of rods in the heavier beams comprising two 1¼-in. and two 1-in. in size, while those of the intermediate beams consist of a pair of 1⅛-in. rods and a pair of 1-in. rods. The concrete portion of the roof is 4 in. thick, and, of course, in union with the concrete of the beams where it rests on them. It is reinforced with ¼-in. rods lying transversely midway between the upper and lower surfaces and by 5/16-in. rods running longitudinally, half above and half below the transverse rods.

The crane runway rails are carried by concrete-steel girders supported by concrete-steel brackets. The bracket extends 15 in. from the column to which it is tied, and is 12 in. wide. The way in which the steel members are tied together and fastened to the vertical rods of the column to which each is attached, is shown, and it may be stated that the laterals in the top are 1 in. in diameter. The crane girders are 10 in. wide and 20 in. deep, and similar in design to the roof beams.

The specifications called for a 1:3:5 concrete with 2-inch stone for the substructures, including the curtain walls, and ¾-inch stone for the superstructures. The reinforcement consists of medium steel of 70,000 lbs. tensile strength, and all the stresses were calculated on the basis of 16,000-lb. unit stress in the steel and 500 lb. per square inch in the concrete. The Lehigh brand of Portland cement was used.

The sand, obtained from a bank a short distance away, proved to be high in loam, averaging about 11.5 per cent. by volume, and its composition and the results obtained on tests with neat briquettes are of interest. The sand consisted of 6.9 per cent. which passed through a No. 1 sieve ; 2.8 per cent. through a No. 2 sieve ; 24.1 per cent. through a No. 5 sieve ; 20.9 per cent. through a No. 10 sieve ; 6.9 per cent. through a No. 20 sieve ; 8.5 per cent. through a No. 30 sieve ; 11.5 per cent. through a No. 50 sieve ; and the balance through 100 and 200-mesh siēves, except, of course, the loam. Tests were made with 1:3 neat briquettes and the results compared with those obtained with 1:3 neat briquettes with the standard sand suggested by the American Society of Civil Engineers ; that is, sand all passing through a No. 20 sieve. Such a standard briquette for seven days is credited with a strength of 205 lb. per square inch, while tests made with the sand employed in the work in question showed with 1:3 briquette a strength, at the end of seven days, of 462 lb. per square inch; with a 1:4 briquette for the same period, 343 lb., and with a 1:6 briquette, 205 lb., the last figure being exactly equivalent to the 1:3 standard briquette. A series of twenty-eight-day results were also obtained, comparing the figures with the 276 lb. credited to the standard briquette for this period ; a 1:3 briquette gave 516 lb. ; a 1:4 briquette, 429 lb. ; and a 1:6 briquette, 281 lb.

Attention is called to the considerable area over which a relatively small amount of concrete was distributed. For example, in the entire screen house, both in the substructure and the framework of the superstructure, there are less than 1,100 cu. yd. distributed over a length of 322 ft., or less than 3½ cu. ft. per running foot. Similarly, for the 600 ft. of intake structure, the total amount of concrete will amount to about 3½ cu. yd. per running foot. The head block, owing both to its location and to the relatively large volumes of the concrete work, did not present the same conditions. The total amount of concrete comprised in the contract for the headwork structures described will amount to about 7,000 cu. yd. Owing to the fact, among other things, that the rock excavation necessary for the intake structure has not been entirely executed, work has not yet been started on this portion of the headworks, but the head block and the screen-house foundations and framework have been completed. This work was started about Sept. 10, and between that date and Nov. 15 the bulk of the work was entirely completed, and the contractor, the Reinforced Cement Construction Company, of New York, considers the expedition with which the work was peformed as noteworthy.

Four concrete mixers were employed, two for the head block and two for the screen house. The concrete plant for the head block was erected in the inner forebay and toward the inner wall, so that materials were readily discharged to it from the adjoining bank. Arrangements were made with the local street railway company for hauling the sand from the sand bank and cement from the railroad cars. Separate hoppers were provided for the crushed stone and the sand, and alongside of these a cement house was provided with a chute for sending the bags of cement from the top of the bank to the cement-house door. The mixer of this particular plant rested on the floor of the forebay below the level of the floor of the cement house, and the mixed concrete was dumped into a bucket which was lifted in place by a derrick of the stiff-leg type with a 90-ft. boom. For the screen house the contractor had to lay down a working track for the delivery of the materials and a self-propelling derrick was used, mounted on another set of rails parallel with the screen house, to lift the bucket to the point of use. Here concrete was mixed in quantities of 1 cu. yd. each, and was dumped from the bucket to be shoveled into the forms.

The difficulties of the work were due to two causes. There were few railroad facilities, and these were more or less congested on account of the large amount of work now in progress in the immediate vicinity on the Canadian side of the river. Labor was difficult to obtain also on this account, for not only was there a considerable demand for it in connection with the general power developments, but the town itself was engaged in a considerable amount of sewer work. The fact that the concrete for the screen-house structure had to be handled in small lots on account of the small sizes of the forms was also more or less of an obstacle to rapid erection. Altogether some 400,000 ft. of timber were required for the forms of the screen house and head block, and the quantity made it advisable to erect a wood-working mill, where a small harvesting steam engine unit and a circular saw were provided, enclosed in a light wooden house. Lumber planed on one side was, of course, purchased, but the power-driven saw was desirable both for cross-cutting and ripping. This house was erected in the forebay immediately below the bluff of the inner bank.

The reinforced concrete work described was designed and constructed by the Reinforced Cement Construction Company, under the supervision of the Niagara Construction Company, of which Messrs. L. L. & P. N. Nunn are engineers, and Mr. O. B. Suhr is resident engineer. The working force varied from 50 to 100, not including the engineers, foremen and carpenters. The enclosure of the superstructures was not included in this work, as concrete blocks are to be employed. Messrs. Green & Wicks, of Buffalo, are the architects for the buildings, which are designed with reference to their location within the confines of the Queen Victoria Niagara Falls Park. The intake structure is to be undertaken next spring, and by contract must be completed within sixty working days.—Abstract from the Engineering Record.

Depreciation of power plants should be charged off at the rate of 10 per cent. annually, according to Mr. R. F. Hayward, chief engineer of the Utah Light & Power Company. This should be figured on the whole cost of construction, whether the plant is operated by steam or water. "The neglect to do this may be hidden by reorganizations or abnormal growth of business," he states, "but it means financial failure sooner or later. It is extraordinary how often people who ought to know better will shut their eyes to this fundamental law of engineering finance."

For more than 20 years researches have been made with a view to fixing on a waterfall capable of furnishing sufficient power to supply St. Petersburg with electricity. Hitherto the most suitable for this purpose appeared to be a cataract in Finland, which it was proposed to utilize for the working of an electric tramway. Further researches, however, have resulted in the discovery of the Kiviniemi waterfall on the river Voksen (46 miles from St. Petersburg,) with energy equivalent to 25,000 horse power. Unless the difficulties of conveying the current rove insuperable, this waterfall will be purchased.

COMPARATIVE ADVANTAGES AND COST OF STEAM AND ELECTRIC POWER.*

By K. L. Aitken, Consulting Electrical Engineer.

When the title of the subject on which I am to speak was given me, I was somewhat perplexed as to whether I was to consider the comparative advantages and cost of putting a boiler and engine in a factory, as against the purchasing of electrical power from a central station, or whether I was to deal with mechanical versus electrical drive. Both questions are interesting, so I have decided to give consideration to each.

Whether power is to be made or bought, the heating of the building must be estimated. The cost of heating depends upon the purpose for which the building is to be used, the size of the building, its plan, the thickness and material of its walls, the number and size of windows and other openings, its exposure, and the external temperature. Having figured this cost, the power and lighting loads must be considered, and knowing the cost of current, it is a simple matter to ascertain the total cost per year for heating, lighting and power.

Installed in the building will be a certain number of motors and lights—therefore, for simplicity, I will consider the cost of generating electricity on the premises to supply this same equipment. The load curve must be carefully made up, and from this is derived the information necessary to decide on the maximum capacity of the plant, and as to how the units shall be divided. Then knowing the load variation, the cost of light and power per year can be figured, this cost including the labor and coal which would have been required for heating were no plant installed. I assume, of course, that the exhaust steam will be sufficient to take care of this heating.

In this way, the two schemes, reduced to a dollars and cents basis, may be considered. Two other important items enter into the proposition at this point; first, if the machinery in the building require a very constant speed, better results will usually be obtained from a plant under your own control; and second, if an accident occur in your own plant, it may mean a shutdown until repairs can be made, while in the case of buying current from a large central station, this risk is almost eliminated.

It is not possible to place before you figures in connection with actual costs—the expense of buying power depends on the supplying company, and the cost of producing depends on several variable quantities. Each proposition must be studied and figured separately—and practically no two ever work out alike. In many cases, an isolated plant, if properly laid out, will show a material saving, while, in the same case, the plant, if badly designed, will mean a serious and irrevocable loss.

To take up the two methods of drive—the mechanical and the electrical—I want to place before you, for illustration, the two extreme conditions, one of which can be found in the roll equipment of the Homestead Steel Works, and the other in the new C. P. R. shops at Montreal. In the former case, the big plate rolls are each supplied with its own boiler and engine—the amount of power required being extremely large, and the engine being attached directly to the roll. In the latter case, the total power used, while being on a large scale, does not compare with one of the single engines at Homestead, and instead of being used at one point, is distributed over a large area. At Homestead there are also some 30,000 horse power of motors used as are the C. P. R. motors at Montreal, and supplied from one power house.

Actual experience shows us that, with the exception of special cases, the capacity of the power house should be considerably smaller than the total of the motors connected. For instance, for the 30,000 horse-power of motors in Homestead, the power house has a capacity of but 4,000 horse power. The works cover such a large area that were mechanical drive used, and all the power delivered by the motors supplied from one point mechanically, the required capacity would perhaps reach 50,000.

In the case of a new factory, costing a total of, say, $500,000, and covering a fairly large area, we find that this total cost will install either mechanical or electrical drive. Although the power house capacity is smaller for the electrical, the first cost of boiler, engine, generator, switchboard, wiring and motors, will be somewhat higher than the first cost of a boiler and engine of the necessary size, together with belts and shafting. Still the saving in the size of all the buildings effected by the electrical equipment just about makes up this difference.

In the comparative operating costs, we find an interesting study. As the first costs are practically the same, the items of interest and insurance need not be considered. Depreciation will almost invariably show a saving in favor of the electrical drive, provided the item for shop attendance be kept the same as it would be for the mechanical. Incidental repairs, oil and waste, and other sundries, favor the electrical. In the power house proper is the greatest saving. The equipment being much smaller as I have already mentioned, the items of labor, coal, and water are correspondingly reduced.

When considering the efficiency of the two systems, the argument is often advanced that if the power of the engine be applied directly to the shop, then such a system must of necessity be more efficient than if the energy be transformed into electricity by a generator, with a loss; transmitted by wires, with a loss; and reconverted into mechanical motion by motors, with still another loss. This is a serious error, for it gives no consideration to the power which is continuously required to drive the belts and shafting. Numerous tests have shown that this will sometimes amount to fifty per cent. of the total energy delivered by the engine. Electrical apparatus has very high efficiency covering wide variations of load; for the purpose of making the point clear, figures in connection with the two methods of drive, applied under similar conditions, may be of interest. Consider that 100 horse-power is required by ten machines, and that with mechanical drive, 30 horse power is needed to turn the shafting. Then, when the machines are taking 100 horse power, the engine will be delivering 130; when using 50, the engine shows 80; when using 25, the engine gives 55, and when taking no power at all, the engine must still deliver 30 to run the shafting.

*An address delivered before the Canadian Manufacturers Association, Feb. 8, 1905.

With the electrical drive, the corresponding figures, given in the same order, are as follows :—

H. P. delivered by motors.	H. P. delivered by engine.
100	131
50	67
25	40
0	13

Therefore, when delivering full power, the losses of the two systems are almost identical ; at half load the saving in favor of the electric drive is 16% ; at quarter load 27% ; and at no load 56%. Working on these figures and assuming that the average load is 20%, then the actual saving in power of the electrical system is 32%. With very few exceptions, the electrical drive means a lower coal consumption.

Now to come to the greatest consideration of all—the relative advantages. Manufacturers, in the past, and I may even say in the present, when about to locate a factory, have given great consideration to the cost of power, and in so doing have overlooked a number of other conditions of much greater importance. For instance, two towns are trying to induce a manufacturer to locate within their limits—one offers power at $15 per horsepower per year, and the other at $12. This will mean a saving of 20% in the power account in favor of one town, and looks worth while, when viewed from a distance. But suppose that the town which offers power at $15 is located on the main line of one of the railways, and that the other is out somewhere on one of the branches—then delays in goods in transit, either raw material coming in, or finished articles going out, may more than counterbalance the saving in the power bill. Therefore, at the best, to give primary consideration to the cost of power, is a very short-sighted policy.

Now, taking the business of manufacturing as a whole, the cost of power is, at the greatest, but a small percentage of the total cost of running the establishment—for example, let us consider it at 5%. If you can make a saving in your power account of 20%, it is certainly well worth while, provided it has no counteracting influence, but it reduces your cost of manufacture but one per cent. While the electrical and mechanical drives have the same initial cost, and the electric has lower operating cost, still there is one point in its favor upon which I have not touched, and that one point overshadows all the rest. With the electrical drive you get something which the mechanical system cannot possibly give you—a truly flexible control. If, without increasing either your power cost or your labor cost,in fact, increasing but the one item of raw material, you can raise your output of finished goods 20 or 25%, then surely the proposition merits consideration. To illustrate my meaning, take the case of an ordinary engine lathe. With the generally used speed changing system of cone pulleys and gears, the speed jumps are often as much as 100%. Consider three abstract speeds, 50, 100 and 200, each being an increase of 100% over the one just below. Take a certain piece of work, and consider that the best speed is 75. You cannot run that lathe at the 100 point and get satisfactory work, and consequently it must be run at 50. This means that the work in question will take just 50% more time to turn out than is really necessary. With the proper system of electrical drive, the lathe could run very close to the 75 point, and therefore at its maximum capacity.

Another point—against the mechanical drive—is that machinery has to be located in the shop with regard to shafting arrangements, while the governing condition should be convenience and rapidity in handling goods. When new machinery is to be added, it may mean material changes in the existing equipment—and such changes cost money and take time. With the electrical drive, extensions may be made without interfering with any part of the plant. Wwith mechanical drive you put your power house where you must; the electrical allows you to put it where most convenient.

Where shafting and big belts are running, the walls and ceilings are invariably dirty, and the shop is dark, to say nothing of the continual source of danger which the belts constitute. It is well known that the brightness and safety of an establishment are factors of the quality and quantity of the output.

Considering my remarks on the drive problem, they may appear rather one-sided, but if this be the case, it is because the proposition is one-sided. There are conditions which unquestionably call for the electric drive, and, on the other hand, conditions exist in many cases where such method of drive would be absurd. I have endeavored to touch on the governing features in a general way, and from an unbiased standpoint ; I sincerely trust that my opinions have been of interest to you.

I thank you, gentlemen, for your attention.

UNIPOLAR DYNAMOS.

By James Asher.

The first unipolar dynamo was used by Professor Michael Faraday, of London, in the year 1831. A few years previously Prof. Barlow had invented a small electric motor, which consisted in a toothed wheel whose teeth dipped into a drop of mercury between the legs of a permanent magnet. On passing a current along the shaft, then down the wheel and out through the mercury, a rotation of the wheel ensued. Sturgeon used a smooth instead of a toothed wheel and found that even then the machine worked as a motor. Now, in 1831 Prof. Faraday used a rubbing contact of wire instead of a mercury contact. Instead of sending a current into the little machine he placed a crank upon the shaft and turned it. A galvanometer in the electric circuit showed that when the user turned the machine in one direction,a current flowed say, toward the right, but when he turned the machine in the opposite direction the current flowed toward the left.

Apparatus designed for showing electric-magnetic rotations, on being mechanically rotated, generated weak currents of electricity. One of these consisted in a straight permanent magnet vertically mounted on pivots. On leading in a current at either one or both poles, and out at the middle of the magnet through a mercury trough, or vice versa, the magnet was set in rapid rotation. On disconnecting the battery and rotating the magnet mechanically, the galvanometer showed the presence of a current of electricity. When the direction of motion was reversed the direction of the current was likewise reversed. The machines so far described were not intended for industrial use.

Werner Siemens invented and constructed a unipolar dynamo which consisted in a horizontal U-shaped electro-magnet, round the poles of which two hollow

cylindrical armatures of copper were caused to rotate. A second electro-magnet, having pole extensions, lay between the legs of this electro-magnet. The pole extensions nearly surrounded the copper armatures. These armatures were divided longitudinally into several sections, each of which was connected with a slip ring and several brushes, in order to increase the voltage.

Delafield invented a machine somewhat similar to that of Siemens. But in this machine the copper cylinders were not divided. The electro magnetic structure formed a consequent pole within each hollow cylindrical copper armature.

Professor Galileo Ferraris, of Turin, Italy, invented a unipolar dynamo. The electro-magnetic system consisted of two horizontal electro magnets laid end to end, and having their like poles in contact with each other. Within a semi-cylindrical cavity extending across the top of the upper consequent pole a plain armature rotates, while below a semi-cylindrical cavity extending across the lower consequent pole another plain cylindrical armature rotates. The lines of force, after passing through the upper armature, traverse its shaft and find their way into the shaft of the lower armature. They next pass through this armature and are led off.

Professor Crocker, of Columbia University, New York, in conjunction with Mr. Parmly, designed several unipolar dynamos about fifteen years ago. One of these consists in two large annular electro magnets standing in vertical plains ; the opposite poles of each field magnet are very close together. A hollow cylindrical armature carried on spokes, or on a spider, rotates with each end within the intense magnetic field. Brushes extend through holes in the magnet and carry off current from the armature.

Mr. C. E. L. Brown, of the firm of Brown, Boveri & Company, on the Continent, designed and constructed a machine somewhat similar to the foregoing.

Lord Kelvin (formerly Sir Wm. Thomson) constructed a unipolar dynamo consisting in a disk at two diametrically opposite points of which stood a vertical field magnet, within which rotated the disk armature. The disk was slit radially into many spokes. The current passed out at brushes pressing on either the broadened edge of the slit disk or on a hoop enclosing the same.

Polecho designed and constructed a machine similar to that of Lord Kelvin. The amperage was very great, but the voltage was low.

Professor George Forbes, of Glasgow, invented an iron-clad unipolar dynamo. A solid iron cylinder six by four inches in dimensions rotated within a thick, hollow iron cylinder, by which it was completely enclosed. Two magnet coils lay in grooves in the casing and opposite the ends of the armature. Brushes extended through holes in the casing near the coils. This machine gave an amperage of several thousand, but it yielded a voltage of only about two.

F. L. O. Wadsworth designed a massive unipolar dynamo having a vertical shaft. The two disk armatures are each divided into several sections connected with annular mercury troughs surrounding the machine. The disk is subdivided and the sections are connected with the troughs in order to raise the voltage. The shaft must be vertical in order to make use of mercury contacts entirely round the circumference of the disk armatures.

Mr. Heath, of the New England States, designed and constructed several forms of unipolar dynamos only a few years since. Perhaps his best design is that in which a massive yoke wound, vertical field magnet stands with hollow cylindrical poles uppermost and looking towards each other. These poles extended within a hollow cylindrical iron armature. This armature is electrically connected with the non-magnet shaft by a web. Brushes press against the armature near its ends. There are or may be several concentric cylinders, each fitting closely over but insulated from that within. Each cylinder may then have its own brushes. The voltage is higher when the machine is constructed in this manner. The current is led off from the shaft by ordinary brushes.

The unipolar dynamo yields an enormous current, but the pressure is very low. In other words, it gives great amperage but low voltage. The amperage per pound of weight of machine is far greater than that from any other machine. Lamination of armature or pole pieces is unnecessary; there is neither moving wire nor commutator. The machine is extremely simple, its first cost is low and it occupies little space. The current is perfectly steady. Did not Mr. Carl Hering write that when a telephone is in circuit with a unipolar dynamo you cannot hear the slightest sound ?

On the other hand, the voltage is very low, usually only from two to five, hence such machines are little used, except for electroplating. In order to secure even these low voltages, the machine must be driven at very high speeds. Difficulty is found in taking off currents of great amperage from the circumference of the rapidly rotating armature. Numerous brushes are requisite, they are liable to heating and wear, and the loss of mechanical power from torque of brush friction is considerable.

Many electrical engineers have tried to design unipolar dynamos which have neither brushes nor slip rings. But no man has yet constructed one which will work.

There appears to be no law of nature which asserts that the thing cannot be done. I think that it can be done ; moreover, I think that I shall soon have in operation a machine of this kind. I have given the subject some thought during the past twenty-two years. I had models made from time to time. All failed to work. I see now why they failed, and why other men's schemes failed. The common theory of dynamos is insufficient and unsatisfactory.

It does not appear that the unipolar dynamo has ever been practically used as a motor. This could easily be done, and it could best be done where either storage or primary batteries are available, for example in electric carriages. The cells of the storage battery might be connected so as to give a current of very low voltage but of great amperage.

I wish to call attention to a statement which is frequently made, to wit, that the term unipolar dynamo is a misnomer. Distinguished writers even condemn the use of the term unipolar as applied to a dynamo. They say, and say truly, that magnets have at least two poles. One writer on the other hand did not condemn the term unipolar. He says that the unipolarity refers to the current, not to the field magnet. A unipolar dynamo is one in no part of which is the direction of the current periodically reversed during the motion of the rotating portion of the machine.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Municipal Ownership. The words "frenzied finance" can well be applied to the public ownership movement that has become so popular with some of our municipalities. They take up the consideration of the building of a power house, and right at the outset say, "We are going to sell power at $10." They don't know definitely what the plant is going to cost, and they have no idea whatever of the running expenses. The result of the whole thing is that when the plant is in operation, they find that $10 power is out of the question, and when an attempt is made to raise the price, the business drops off. There is a law in the State of Massachusetts which prohibits any municipality from selling gas or electricity below the real cost of manufacture, and if we had such a law in Canada it would be a very good thing. Then every Council, before building a new plant, or taking over a privately owned one, would make a most careful investigation of the cost of production, and the guesswork feature which how characterizes such deals would be eliminated.

Lamp Renewals. It is indeed surprising how little attention the average central station manager gives to the subject of controlling the incandescent lamps which are used on his circuits, and also how limited his knowledge is in regard to the advantages which arise from such control. Primarily, it is his business to supply electrical energy, and he seems to lose sight of the fact that his customers purchase this energy with the sole object of obtaining light therefrom. In our last issue, when speaking of the Montreal Light, Heat & Power Company, we said that it was the central station's chief desire to maintain friendly relations with the public. We might have gone somewhat further and explained that "friendly relations" usually result from a service which is satisfactory in every sense of the word. Very few consumers, where they have to buy their own renewals, will make such purchase until their lamps actually burn out—and then only with much grumbling. The direct result is that the consumer kicks when he has to go down into his pocket for money, and also kicks because his light is poor. On the first ground, he really has no complaint; on the second, he has, but its remedy is entirely within himself. He knows nothing of voltage, efficiency, and such like terms; candlepower, especially *sixteen* candlepower, is in his mind to a certain extent, but is regarded as a species of myth. Now, if a man contracts a bill with us to the extent of ten dollars, we find it more satisfactory to have him make payment in a lump, in preference to, say, a dollar a month plan. It may shock him to hand over ten dollars once, but it will shock him much more to have to hand over one dollar ten times. It is really the same in the end, but is far from appearing to him in that light. There you have the position of the consumer who buys his own renewals. Should he purchase a fairly good stock right at the outset, he would not feel so badly about replacing a burnt-out lamp; but when he buys them piecemeal, things appear to him somewhat differently. And besides—and this is the important point—he purchases the cheapest, longest-life lamp he can obtain, and much to his disadvantage. Therefore, it will be seen that when the lamps are out of the control of the central station manager, dissatisfaction is almost

sure to exist. The disease cannot be cured, but its cause may be removed. To make the removal permanent and complete, the renewals should be given *free.* But how, and it is but a natural question, can any company afford to replace dim or burnt-out lamps with new ones, and make no charge therefor? They do not. But the consumer thinks they do, and can find no explanation, nor is he given any. Hence he is happy, he has good bright lamps and good light in consequence, and in his mind he cherishes the idea that the lighting company, though much abused, is really a philanthropist in disguise. Here is a condition which to our mind may be characterized by the term "friendly relations." But the consumer pays for his renewals just the same, though he may not know it. The lighting rate is made up to include the cost of "free" lamps, and when the little monthly, or quarterly bill, is received, you may truly say that a certain percentage of it is for new lamps furnished; only, as we said before, it does not appear in that guise. Let every central station manager give due consideration to this all-important subject, and the time he spends in studying the proposition will not be wasted. Mind you, furnishing new lamps at cost, or half cost, or at any charge whatsoever, will not accomplish the same results as if they are given free for the asking. And all lamps received back—make that a point, the old lamp, glass unbroken must be returned—are not useless; in many cases a little soap and water will make them as good as new. Experiment with your lamps; get the make best suited to your service, and buy in large quantities to get close prices. Do not get all the same voltage—there may be points in your town where the pressure is low, and therefore a lamp of lower voltage will give better results. There is one more point, and it is worthy of consideration. There are certain standard voltages used throughout Canada, and for illustration we will take 104 and 110. When a representative of a lamp house next comes your way, take him quietly aside, talk to him earnestly, and no doubt he will make you a nice low price on 102 and 108 volt goods, which he can ship in large quantities, and at once.

Light and Crime. While our Canadian towns and cities are comparatively free from crime, still there is a point in connection with this subject which every municipality should bear in mind. Rowdyism, which constitutes crime in an incipient stage, is probably the most objectionable condition from the standpoint of the pedestrian, and wherever there is a specially dark street or corner, there you will find a rendezvous for all the young hoodlums in town. The remedy is simplicity itself. Make the street light, and the trouble will disappear, if not entirely, then to such an extent as to more than warrant the expenditure for the light. The next time your municipality is considering the wisdom of putting on an additional constable, get up at the council meeting and advocate that the money which they propose to spend on the police force be used for the installation of more arc lamps. Prepare convincing arguments to back your idea, and it will probably be adopted. There's a lot of good common sense in the scheme—the constable will not be on the dark streets continuously, but the lamps will do away with such streets. No less an authority than Police Commissioner McAdoo, of New York, has said in connection with this subject, "I have always believed that light would prevent a great deal of disorderly conduct at night in certain streets. I do not know of anything so effective as a means of ridding us of our many troubles. If they were to give me charge of the lighting of New York, as well as its protection, I would at least double the number of lamps now in use." Keep the thing in mind—a brightly illuminated town stands for a place characterized by progressiveness. If a business man goes to a certain place, with the object of locating a factory site, and has to stumble up from the station in the dark, the primary impression is not good, and as we all know, the initial impression is the hardest to eliminate. On the other hand, should he find the town literally flooded with light, it is certainly a material point in favor of that particular location.

Lifting Magnets. The older we grow, the more we seem to learn, and the more we appreciate how little we really knew just a few years back. Phenomena, with which we have long been familiar, suddenly finds some new application, and we begin to realize that this same familiarity is not always a good thing—sometimes it breeds contempt. To those of us who manifested electrical inclinations in our early days, the magnet was probably the first step in our technical education. The magnet would attract and lift iron or steel, and the larger the magnet, the stronger this attraction, and the heavier was the metal which it would lift. This was certainly interesting, but as time passed, and the electro-magnet with its enormous power came into its many applications, we seemed to lose sight of the original experiment—that the magnet would *lift* iron and steel. The date of the commercial application of this property is not many years back, and to-day we find that the lifting power of the electro-magnet is of enormous value. In place of the cumbersome chains, which have heretofore been used in connection with crane work, a properly designed electro-magnet is suspended from the hook, lowered over the article to be carried, a switch closed, and all is ready for the lift. And instead of the time required with the old systems, it all can be done in as few seconds as it takes to tell it. Consider the saving in time, the saving in the wages of the crane gang, the safety, and the convenience of the thing. Before, when a heavy casting was set down, blocks were placed beneath it, so as to make possible the slinging of chains. Now that is not necessary. Plates, and like shapes, can be piled close together, thus effecting much economy in storage. And then there is the handling of hot castings, even red hot castings, which used to be the bane of the foundry chainman's existence. And the wonder of it all is that this use should be a recent, instead of an ancient application. But, no doubt, there are many things hidden from us yet. Twenty years ago it was said that all there was to be known in connection with electricity was then known, and ten years later the same remark was made. To-day we hear it occasionally, but those of us who know, know that we don't know, and the future holds many things in store for us.

The Western Manufacturing Company, of Indian Head, N. W. T., have installed an electric lighting plant in their works.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. NO. 1.—I see on page 241 of your December issue mention of the Ganz system which the South-western Traction Company, of London, are putting in. Can you tell me how this system works?

ANS.—The Gans system of electric railway propulsion consisfs of alternating current motors, of the induction type, connected in concatenation; that is to say, in series. When an induction motor, with a short-circuited rotor, is connected to a source of power, the speed is practically synchronous. If, however, the motor rotor is provided with collector rings and a straight alternating current winding, similar to that of the stator, and the rotor locked, then the machine will act as a transformer, the rotor winding giving out alternating current of the same frequency as applied to the stator. If the rotor be allowed to run at half synchronous speed, then the frequency of the current which it gives out will be half that of the circuit to which the stator is connected. This is the principle of concatenation, as used with induction motors. In the Ganz system, two motors are supplied, the first being equipped with collector rings on the rotor, and the second having a short-circuited rotor. With the rotor winding of the first motor short-circuited, it will run at synchronous speed when connected to the line, as will also the second motor. To get a constant half speed, however, the stator winding of the first motor is connected to the line, and the stator of the second motor is connected with the rotor collector rings of the first motor. Intermediate speeds are obtained by means of auto-transformers, or other similar devices. In the system to be adopted in London, the trolley voltage will be either 1000 or 2000. For this particular installation a novel feature has been introduced, and that is the motors will also operate on 550 volts direct current, with the regular series-parallel control. If direct current be passed through the stator winding of an induction motor, definite poles will be produced, similar to a certain extent to the poles of a direct current series motor, though perhaps being greater in number. This fact is made use of when the motors are on the direct current circuit, the stator winding acting as the field winging of a straight series motor. The armature arrangement differs materially from anything which has heretofore been placed on the market. It is practically a double armature, having an induction motor winding and a direct current winding with a commutator, both windings being entirely separate. Thus the motors can be converted at will into either straight series for direct current or concatenated induction for alternating. For running in the city of London the direct current will be used, while for the long lines outside the alternating will come into play.

QUES. NO. 2.—A barbed wire fastened on the tops of poles with staples, strung over a high voltage transmission line, has given considerable trouble breaking off at the staples where rust has weakened the wire. Would you recommend that it be all taken down? Has this method of protection proven satisfactory? Are new transmission lines still using barbed wire for protection?

ANS.—The reason that you have had trouble with the wire breaking at the staples is that in putting it up, the staples have cut through the galvanized surface of the wire, and thus exposed the bare iron to the action of moisture. With this weakening caused by rust, there may be combined the possibility that the wire is stretched too tight. If these breaks occur frequently, we certainly think that you will be repaid by taking the wire down altogether, for such breaks will, we think, mean short-circuits, and possible damage to the line and power house apparatus. If, in your particular case, the barbed wire really affords some protection, it will undoubtedly pay to replace the old wire with new, care being taken to see that it is properly put up. The protection which is given a transmission line by stringing on the same poles a grounded wire, is very questionable. Many prominent engineers hold that the scheme is a good one, and cite instances, to sustain their views, where plants which were bothered by lightning to a great extent were almost entirely relieved when a grounded wire was strung. Other equally clever men have held that the barbed wire is nothing but a source of continual trouble, and that it cannot be of any real use. Generally speaking, it seems that in one locality the grounded wire is of value, while in others it is useless. That is the consensus of opinion on the subject, and the engineers who have in the past held and expressed radical views on the subject, are now modifying their opinions. However, taking all the new plants as a whole, it is a very noticeable fact that in the majority of cases the grounded wire is left out.

QUES. NO. 3.—What protection from lightning would you recommend for telephones where the lines are run on the same poles as a high tension transmission line?

ANS.—Practically nothing can be done out on the line itself, the terminals being the best point for the application of proper protective apparatus. There is a device made by several companies, which consists of a fuse and a small lightning arrester of the telephone or telegraph type. The fuse should be of the enclosed style, made for a voltage the same as carried on the transmission line, and should be as small in capacity in amperes as can be used, or obtained. The lightning arrester consists of two little carbon blocks, pressed together by springs, and just separated by a thin sheet of mica, the mica having several holes cut in it. This makes an arrester that will discharge very easily, and the device should be connected with the fuse between the line and the arrester. This scheme will also be a very serviceable protection in case the telephone line becomes grounded with the high tension line. We would strongly recommend, while on this subject, that a well insulated stool be provided before each instrument, and that no one be allowed to talk who is not standing on this stool. Another thing which will tend to prevent accidents is to make a strict

rule that when using the 'phone, one hand only is to be employed for the necessary manipulations.

QUES. No. 4.—Does the deflected pointer on a G. E. three-phase electrostatic ground detector indicate that the line wire connected to it is the grounded wire? Please explain the action of this type of ground detector.

ANS.—On the three phase meter mentioned there will never be a deflection of one needle only. In the case of a ground existing on one wire, two of the needles will point to the segment to which the grounded line is connected, and the third needle will be at zero. If two of the lines are grounded, one needle will point to one grounded segment, and one to the other grounded segment. The needle between the two grounded segments will point to zero provided that the grounds are of equal resistance; if, however, they are unequal, then the third needle will point to the segment attached to the line having the ground of lower resistance. If you will refer to Question No. 1 (a) of our January issue, you will find a rough description of an electrometer. The static ground detector works on the same principle—if two plates are charged with electricity of opposite polarity, they will have a tendency to come together. In commercial instruments, the plates are made stationary, as in this manner it is easier to effect a good insulation. A third plate or vane, so suspended as to swing easily, is placed near the two stationary plates, but hanging so that it is between and not across them. When a potential is applied to the stationary plates, the moving vane tends to take a position across them, thus in reality doing the same thing as if the two plates moved together—the actual distance through the air between the two plates is shortened.

PARALLELING THE LARGEST TURBO-ALTERNATOR IN SERVICE.

In the latter part of December, 1904, a 5,500 kw., 25-cycle, turbo-generator built by the Westinghouse Co. was put in operation in the Seventy-fourth Street station of the Interborough Rapid Transit Company, New York. It was the first Westinghouse unit of this size to be put in service, although a number of similar machines are approaching completion. The next day after this machine was put in service, it carried loads as high as 8,000 kw., and for considerable periods loads between 7,000 and 8,000 kw. were of common occurrence. This turbo-generator is the largest now in service.

Within a few days after the machine was put in service, and while operating in parallel with six of the slow-speed, 5,000-kw. machines in the same station, a short-circuit occurred among the main leads at a point between the turbo-generator and the switchboard. This was a dead short-circuit and it tripped the automatic switches on all the slow-speed machines, which were set at almost three times full-load current, but did not trip the safety switches on the turbo-generator on account of the fact that the arc was so violent that it burned off the leads to the safety devices for this particular machine, though these leads were in a separate conduit. It was necessary to cut the turbo-circuits off by hand and the short-circuit therefore continued on this machine some little time before it was cut out. Careful examination of the generator showed that it was absolutely uninjured in any way, as far as could be determined, and was ready for service immediately afterwards, but could not be thrown in with the other machines on account of the main leads to the switchboard being burned off. The machine has been in service with heavy loads since these leads were replaced.

The 5,500-kw. turbo-generator is run in parallel with the other machines in the station and the only notable difference in its operation and that of the slow-speed machines is due to the difference in the speed regulations of the two types of engine. The steam turbine was adjusted so that it regulated much more closely in speed than the slow-speed engines and, in consequence, the turbo-generator takes the fluctuations in load. It is noted that when the turbo-generator is operating in parallel with the slow-speed machines, that the latter machines carry a much steadier load than when the steam turbine is cut out, the turbine unit appearing to take all the fluctuations when it is in circuit. This unit, therefore, has something of the effect of a fly-wheel or a storage battery on the system. This effect, if considered undesirable, can be modified readily by adjusting the speed characteristics of the steam turbine.

On account of its uniform rotative velocity and its relatively large fly-wheel capacity, the turbo-generator is particularly suitable for operating rotary converter systems such as the Interborough. Such machines also operate extremely well in parallel, and the operation of a steam-turbine unit with a reciprocating unit is, in general, considerably better than reciprocating units with each other, due to the fact that the mean rotative velocity of the combined units is better than in the case of reciprocating units alone. In the case of the Interborough slow-speed generators, this effect is not noticeable, as there is no evidence of periodic speed fluctuations in the slow-speed units, due to a large extent to the heavy dampers on the machines, their large fly-wheel capacity, and the proportions of the engines which are designed for very small angular variation.

Some months ago a series of tests was made to determine the paralleling qualities of turbo-generator units. At full voltage the machines ran perfectly in parallel. Fluctuations in speed were so slight that periods from one to fifteen seconds could be obtained for synchronizing. When the voltage was reduced to 60 per cent. of the normal, the machines would carry the full current without any evidence of hunting. The voltage was further reduced and tests were made, until about 15 per cent. of the rated voltage was obtained. Under these conditions the machines still remained in parallel when carrying full-load current, but the conditions of paralleling were not perfectly stable, the load being transferred from one machine to the other at an irregular but not rapid rate. As the synchronizing power varies approximately as the square of the voltage, it was extremely low in the last test cited. It is evident, therefore, that but small interaction is required between such machines to maintain parallel operation.—From the Electric Club Journal, Pittsburg.

The test of a 30 h.p. Diesel engine, reported some time ago in the "Mechanical Engineer," showed a consumption of crude Texas oil of 0.49 lb. per brake horse power hour when developing 28.6-b.h.p. and a thermal efficiency of 36.1 per cent.

MODERN CENTRAL STATION DESIGN AS EXEMPLIFIED BY THE NEW TURBO-GENERATOR STATION OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.*

By I. E. Moultrop.

The Boston Edison Company's system supplies electricity to a heavily-loaded business section of the city, which covers a comparatively small area located within a mile of the water-front. This business is supplied by a direct-current station on the water front, having 10,500 kw. of machinery, with room to increase the capacity to 14,500 kw. Surrounding this business section is a city residential district where the load is considerable, although much lighter than in the business part. Here the customer receives direct current from sub-stations supplied, through motor-generator sets, from the existing alternating-current station of 9,000 kw. capacity, located on the L Street property. The output of these sub-stations being direct current, they are, with one exception, equipped with storage batteries.

Within the last two years the Boston Edison Company have purchased the property of many local companies in suburban places, and in most instances are changing the stations to modern alternating-current sub-stations, making a suburban business which extends in various directions from 12 to 30 miles outside of the city.

This large increase in suburban territory, together with the rapidly-growing city business, called for an immediate enlargement of the alternating-current station which was already loaded to its full capacity. A new station was therefore planned with an ultimate capacity of 60,000 kw., to be built on the L Street property alongside the existing station. The first installation of 10,000 kw. is just being completed. The old station naturally merges into and becomes a part of the new station.

The value of real estate being small, it was considered cheaper to spread out the buildings on the ground than to carry them up in the air to an equivalent area.

The turbine-room, when completed, will be 650 feet long, 68 feet wide, 56.5 feet high, and without a basement. The boiler-house will be 640 feet long, 149.5 feet wide and of the same height as the turbine-room. The arrangement of the boilers practically divides this building into seven fire-rooms.

The switch-house will be 605 feet long, 30 feet wide, and several stories high. The buildings for the installation of 60,000 kilowatts of machinery cover about 160,000 square feet, which is equivalent to about 2.67 square feet per kw.

In designing this station the grouping of the apparatus has been given special attention and care has been taken to so arrange them that they naturally come under the charge of the class of operators best fitted to care for them. The turbine-room has received all of the machinery in the station ; even the boiler feed-pumps usually considered an adjunct of the boiler-house are treated as part of the turbine auxiliaries, and are placed in charge of the turbine operators. The boiler-house contains only the boilers with the necessary piping, etc., so that the work in this room is to burn coal properly and maintain the steam pressure.

All of the electrical apparatus has been grouped together and installed in a separate building adjoining the turbine-room.

The apparatus is installed on the unit system. In the turbine-room all the auxiliaries required for a generating unit are grouped around that unit and are generally of sufficient capacity to serve that unit alone. The boilers necessary to supply the generating unit are in one row directly behind the turbine. In this way each generating unit is a small central station in itself. Practically no cross-connections are installed between the various units except that between each pair of units. The steam mains are joined by a small-sized tie so that a generating unit can be run temporarily from the boilers of its mate, shonld an emergency require. In this way a very simple piping system is sufficient, reducing the cost of installation and maintenance, and simplifying the manipulation of the station under emergencies when the engineer has to think quickly, and when he must be sure that the manipulations are made rapidly and correctly.

Before determining upon the apparatus to be installed in the station, careful consideration was given to the respective merits of turbines and reciprocating engines as prime movers. The advantages of the turbine over the engine in first cost, the lesser amount of help required to operate, the ability to use condensed steam with safety for feed in the boilers, together with the fact that the apparatus takes very much less room , decided the question in the favor of the turbine. These considerations were held to justify the decision without regard to the water consumption, and the decision will be considered wise even though the water consumption proves to be no better than that of a good engine, although it is expected to be better. Another important feature is the ability to start an idle unit quickly. The earlier turbines were open to improvement in this respect, but the later machines have been safely started and brought up to full load with remarkable speed.

The turbines used in the first installation are of the Curtis type with a rated capacity of 5,000 kilowatts on a conservative temperature rise in the generator. They are four-stage machines with surface condensers built in their bases and are equipped with mechanical brakes for bringing the machine to rest for an emergency stop. In these features they are the first machines of their kind to be installed. The base condenser was adopted because it will give a somewhat better vacuum in the turbine, which is an important consideration in turbine work. It also considerably reduces the floor spa e required for the installation, somewhat simplifies the piping, and makes possible a more symmetrical and pleasing grouping of the machinery. Its disadvantage is that it increases the height of the turbine a few feet, which is, however, of little moment. Its first cost is somewhat more than an independent condenser, which may be partly balanced by the saving in piping ; and it requires special arrangement for filling the condenser tubes with water when the turbine is to be non-condensing.

The brake is very useful for emergency shut-downs, because the turbine will run for some hours with no load and no field, while with the brake it is possible to bring the machine to rest in about five minutes. It also facilitates the overhauling of the step bearing by sustaining the weight of the rotating parts.

The generator is a three-phase alternator, Y-connected, 60-cycle machine, generating at 6,000 volts. This number of cycles was determined upon because the bulk of the alternating-current business is lighting, and also for the reason that the existing alternating-current apparatus has the same number of cycles.

The auxiliaries for each turbine consist of a circulating-pump, a wet and a dry vacuum-pump, a step-pump, a hydraulic-accumulator, and the boiler feed-pump for the group of boilers connected to the turbine. All these machines are steam driven with the exception of the wet vacuum-pump, which is motor driven because its speed is too high to be conveniently handled by an engine. Careful consideration was given to the subject of steam versus electrically-driven auxiliaries, and steam was determined upon because it gives better station economy. All the exhaust steam from the auxiliaries is carried to the feed-water heater and is condensed in heating the boiler-feed. The condensation is then discharged to the sewer,as it contains too much cylinder oil to warrant trying to purify it.

The circulating water-pump consists of a centrifugal-pump driven by a simple high-speed engine with a throttle governor.

The distinctive feature of the dry vacuum-pump is that the air-cylinder is placed at a right angle to the steam-cylinder, thus giving a better turning moment on the crank, and it takes less room.

The step on the turbine is lubricated by water instead of oil, because the water is as good a lubricant for this purpose, is cheaper, and the lubricating system simpler. The water is forced into a step under a pressure of about 1,000 lbs. by a steam pump of similar design to the boiler feed-pump. As even a momentary stoppage of the water supply to the step would result in damage to the bearings, a motor-driven triplex-pump, which can be started much quicker than a steam-pump, is installed as a relay to the main step-pump. To obviate fluctuations in the pressure due to the pump reversing its stroke, a weighted hydraulic accumulator is used. This is made of sufficient capacity to keep the step supplied with water for ten minutes, thus giving time either to shut down the turbine by means of the brake or to put the relay pump in service, should the steam-pump fail.

The condensing apparatus is designed to condense 153,000 lbs. of steam per hour and maintain a 28-inch vacuum in the condenser, with the cooling water at summer temperature of 70 degrees Fahrenheit. The cooling water is conveyed to the pumps by brick tunnels running under the center of the turbine-room, at such grade that they are always flooded, and constructed within the building so that the machinery can be installed above

*Abstract of a paper presented before the American Institute of Electrical Engineers, New York, January 27, 1905, and reviewed for discussion before the Toronto Branch by Mr. R. T. MacKeen, February 10, 1905.

them. For additional insurance, two tunnels are provided for the incoming water, each supplying one-half the station. The notable feature of this system is the intake construction at the sea wall. Racks and screens, provided to keep out all floating material, are so installed that they require very little cleaning, and the screens are arranged to be easily removed and cleaned without permitting debris to pass into the tunnels. Where the tunnels join the screen chamber, heavy timber gates are provided so that the tunnels may be pumped dry for inspection or repairs.

The rows of boilers are placed in pairs alternately face to face and back to back, with a chimney for each pair midway of the row and between them. Thus six chimneys in all are required, each being 230 feet high above the level of the grates, or sufficient to dispense with forced draft. Building the chimneys between the rows of boilers considerably increases the ground area of the boiler-house, but the additional space is very useful for work-room, toilet-rooms, etc. The boilers are elevated from the ground to provide liberal space beneath for ash handling. Large brick chambers immediately below the boiler furnaces collect the ashes, and discharge through valves in their bottoms into carts or cars on the ground floor. Other distinctive features of the boiler-room are the provisions for bringing air to the furnaces, the location of the piping mains, and the small capacity of the coal-bunkers.

The grouping of boilers and turbines which has been adopted gives a smaller amount of piping than would be the case were the boilers placed in the usual manner in two rows, parallel to the turbine-room, and makes a very short smoke-flue with a minimum amount of reduction in the draft.

The amount of superheating, 150 deg. fahr., was made conservative to be sure that the temperature would not cause trouble with flanged joints and in the steam cylinders of the auxiliaries. The attached type was selected because they took no additional room and are self-regulating. Use of superheaters at the direct-current station shows a gain of about 90% per 100 deg. fahr. of superheating in the engine economy, and while with the attached type it is impossible to make comparative tests with and without superheaters upon the same apparatus, the station economy indicates a substantial net gain by moderate superheating.

No economizers have been installed because of their doubtful value under the operating conditions of this station and of their effect on the chimney draft, which is liable to cause a reduction in the capacity of the boiler plant at the time when the maximum is needed, or else make it necessary to cut the economizers out of commission at a time when they would be most useful.

The storage of coal is a very esstential feature of a large central station, and is seldom adequately taken care of. Alongside of this station and adjacent to the water front an open-air storage of from 60,000 to 70,000 tons of coal is provided where the coal is stored without any shelter and immediately on the ground. The coal-wharf is equipped with an electric tower, operating a one-ton clam-shell bucket and one electro-hydraulic tower operating a similar bucket of 1.5 tons. The electro-hydraulic tower is a new design in which hydraulic-elevator cylinders furnish the power for operating the bucket. The water pressure is obtained by a three-stage centrifugal pump driven by an induction motor.

The water-supply for the boilers is of equal importance to that of the fuel. Water-service pipes of ample capacity for the total station are brought into it from large mains in the two adjacent streets. These will shortly be fed from separate trunk mains. For a further safeguard to the water-supply, a system of storage-tanks, with a combined capacity of 50,000 cubic feet of water or sufficient to run one turbine on the condenser for about ten days, is installed on the ground alongside the station building and at an elevation considerably above that of the feed-pumps.

We now come to the general arrangement of the switching. There are of necessity three bus-bar pressures, the excitation, and the possibility of a fourth pressure being required later. The engine-driven alternators generate, as stated above, at 2,300 volts, and the turbine-driven alternators at 6,900 volts. This latter was fixed upon after careful consideration of the location of the present business with reference to the station and of its probable growth. There is also a certain amount of 4,600-volt business which crept into the system some time previous because a considerable amount of business developed at a distance too far away for the economical use of 2,300 volts, and the standard cables on the system would safely carry only 5,000 volts. Therefore, the simplest expedient at that time was to install two-to-one transformers and supply them from the old station bus-bar. This business, which started in a small way long before a turbine station was considered, had grown to a considerable size at the time the turbine was installed, and the loss in the underground cables and other apparatus—which would have no commercial value in case this pressure was changed—prohibits making any change at the present time. The turbine pressure of 6,900 volts promises to be ample for the present needs of the company, but it can be easily foreseen that should the lines be extended beyond their present limits or should the business at theend of some of the transmission lines materially increase, this pressure might be too low. If this happens, it is planned to double the pressure on the transmission lines in question and transmit in these instances at 13,800 volts. All transformers installed on these lines are built with 13,800-volt taps.

The bus-bars in each system are installed in duplicate, and so arranged that they can be cut into short sections of no more than 10,000 kw. each by tie-switches, and any transmission line or generator can be isolated if it is desired to do so. Transmission lines are grouped with the generators on a section of bus-bar so that this bus-bar does not have to carry much current any distance lengthwise. The generator is connected to the bus-bars through one main-switch and two selector-switches. These switches are designed to open under the full station capacity, should emergency ever demand it. The transmission lines have selector-switches but no main-switches at present, space being reserved for the installation of selector-switches should they prove desirable later.

The switches are all installed on the third floor of the switch-house. The selector-switches are in two rows. Each row consists of two switches (placed back to back) running through the center of the building and immediately over the bus-bars they connect to. The main-switches are installed in two single rows, one on each side of the switch-house and against the side walls. On the floor below, the bus-bar compartments are arranged similarly to the selector-switches, two rows of two through the center of the room. In two single rows on each side wall immediately under the main-switches are grouped the instrument transformers in special compartments.

The oil-switch cells, the bus-bar chambers, and the instrument transformer chambers are all built of a light-yellow brick with a fine cement joint, the brick being selected for its low absorption properties. The barriers in the bus-bar compartments and also in the instrument compartments are of reinforced concrete with a fine, close-grained finish. These are all made in moulds and set in place similarly to slabs of alberene; they have as good insulating qualities as alberene with less absorption, are much cheaper, and furthermore are less liable to break. The bus-bar chambers are fully enclosed, small doors being left in the wall for access to the connections only. The instrument transformer cells are left open. The front of each switch-cell is enclosed with a wooden frame filled with a pane of glass which permits an inspection of the pot, while at the upper part of the frame there are a few slats for ventilation, and for vents in case of an explosion.

AGE LIMIT FOR BOILERS.

The plates of an old boiler that had been in use since 1859 exhibited, on tests of 812 test-pieces cut from it, a marked lack of elasticity. According to the report in the *Zeitschrift* of the Society of German Engineers, the boiler had been fed with pure water and never over-strained, so that it was concluded that its unsatisfactory condition was the result of prolonged stress, and that subjecting it to a strain might have led to an explosion. It was felt that the test showed that a boiler should be discarded at the end of 35 years' service and even if apparently in good condition should be replaced by a new one.

Mr. C. J. Brown, City Clerk of Winnipeg, Man., is asking for tenders up to February 13th for snpply of two 250 h.p. water tube steam boilers for the city waterworks.

The latest addition to the list of trade journals of this country is The Canadian Machine Shop, published by Messrs. Biggar, Samuel Limited, of Toronto and Montreal. As the name implies, it is devoted to machine shop practice, mechanical engineering, foundry work, drafting and pattern making, and the first issue shows it to be a thoroughly practical journal. It is published in magazine size and contains seventy-six pages, the subscription price being $1 per year.

ELECTRIC LIGHT INSPECTION.

The report of the Inland Revenue Department just to hand furnishes the particulars of electric light inspection in Canada during the year ended June 30th, 1904. The fees for the inspection of meters were $18,823.75, while for registration of companies there were received $4,435, making a total revenue of $23,258.75. The expenses of inspection were $6,204.63 and there was expended on instruments, etc., $1,842.37, leaving a net revenue of $15,211.75. The report states that since the year 1896-97 the two services of gas and electric light inspection, which are conducted largely by the same staff of officers, have reached that point at which they have ceased to be a burden upon the general taxpayer, as shown below :—

	Gas and Electric Light.	
Year.	Revenue.	Expenditure.
*1899–1900	$35,523.50	$26,424.48
*1900–01	37,536.57	28,247.20
1901–02	45,663.05	33,328.48
1902–03	49,054.55	36,006.47
1903–04	50,218.75	33,426.15

*Exclusive of cost of standard instruments.

There were presented for inspection 15,576 meters, of which 15,500 were accepted as coming within the error tolerated by law; 66 were rejected, and 8 were verified after first rejection. In the previous year 124 meters were rejected and 28 were verified after first rejection. The details for the fiscal year ended June 30th, 1904, follow:

Districts.	Number Presented.	Verified as within the error tolerated by law.			Rejected.			Verified after first Rejection.		
		Correct.	Fast.	Slow.	Unsound.	Fast.	Slow.	Correct.	Fast.	Slow.
Belleville	315	132	67	116						
Hamilton	810	263	238	306	2		1			
London	795	261	270	261		2	1			
Ottawa	2,135	441	231	1,460	2		1			
Toronto	2,308	573	946	778		9	2			
Montreal	2,702	1,683	868	124	5	5	17			
Quebec	997	329	634	31					1	2
Sherbrooke	41	10	16	14		1				
St Hyacinthe	99	98			1					
Three Rivers	39	12	13	14						
St. John	1,052	455	309	280		2	3			3
Halifax	611	551	23	22	5	3	5	2		
Charlottet'n	158	52	67	38	1					
Winnipeg	1,320	923	151	246						
Vancouver	1,392	362	255	775						
Victoria	802	371	192	239						
Totals	15,576	6,516	4,280	4,704	16	22	30	2	1	5

There were registered under the Electric Light Inspection Act 340 companies, an increase of sixteen over the previous year.

A cable road nearly 4,000 feet long forms part of the electric traction system of Palermo, Sicily, to assist the cars over a grade averaging 12 per cent., with 13.17 as a maximum for about 650 feet. The cable passes around a wheel fixed at the top of the grade, and each end is attached to an electric locomotive weighing 8.7 tons. In operation a car is coupled to the locomotive at the top of the incline and another car to the second locomotive at the bottom, and the two pass at a turnout at the center. At the bottom the locomotive descends into a pit between the running rails for the cars, the rails for the locomotives lying between the others. The car to be hauled upward passes over the locomotive, so that it can be on the upward side of the locomotive on reaching the upper limit of travel. One car descends as the other ascends.

MONTREAL

Branch Office of THE CANADIAN ELECTRICAL NEWS,
38 Alliance Building.

February 8, 1905.

The past year might have been better among the electrical fraternity in Montreal. Several happenings told against local business, such as the late spring in 1904, followed by trade strikes in the building line ; then a comparatively cool summer—killing fan motor sales. In the fall, when building became active again, operations were hampered by continuous rainy weather.

After one of the hottest fights on record the real estate proprietors of Westmount, the western suburb of Montreal, voted permission to the Town Council to establish an electric light plant if more favorable terms cannot be procured from the present contractors at the expiration of their present contract. Messrs. Ross & Holgate were the electrical engineers employed by the town to report on the scheme.

The Royal Victoria Hospital had the misfortune to have a fire in the Administration building. For *once* the daily press did not put it down to "electric wires." Great credit is due the staff of the Bell Telephone Company for prompt resumption of their service in and from the institution. The local switchboard was situated two flats under the kitchen, where the fire originated, and was consequently damaged by water. The cause of the fire was ignition of a large vessel of cooking fat, by the range.

A slight damage by fire occurred lately at the Shawinigan step-down station operated by the Montreal Light, Heat & Power Company. The cause is given as a short circuit. The local fire brigade might have extinguished it with the aid of a Babcock, but instead got a stream from a hose playing on it which caused considerably more damage than the fire itself.

The Central Electric Company, who have lately opened up for business on St. Peter street, Montreal, for the supply of light and power, is largely owned by Mr. S. Carsley. Mr. Carsley has been happy in his choice of a manager, having secured Mr. Chas. Morton, lately the popular manager of the Temple Electric Company. The Central Company operate at 220 volt d.c. The plant is run by steam power, the engines and dynamos being both of English construction, and running with remarkable freedom from any vibration. Several good contracts have already been secured.

The Electrical Contractors' Association has, through general apathy and lack of interest of its members, become dormant. No meetings have been held for a considerable time, and although it cannot actually be called "dead," yet it certainly has fallen into a deep sleep Financial troubles did not exist, and no blame can be laid to lack of funds. One factor was the intense competition, which caused many to believe they would be binding themselves to some conditions which might mitigate against their business, and hence stood aloof. No such conditions, however, existed, and it is a pity that such an association, formed purely for common defense and the furtherment of the trade, could not be made a live interest.

The breakdown of electrical machinery has been investigated by the Engine, Boiler & Employers' Liability Insurance Company, of Great Britain. The report for 1903 shows that 14 and 12 per cent. of the breakdowns were due to accidents, the first figure being for dynamos and the secound for motors ; that 10 and 15.5 per cent. were attributed to dirt and oil ; that 24 and 19 per cent. were the result of age and deterioration ; that 3.5 and 5.5 per cent. arose from overloading ; and 13 and 29.5 per cent. were not ascertained, the figures throughout being for dynamos and motors, respectively.

The new electric lighting system which is owned and controled by the city of Moose Jaw, Assiniboia, is now in effective operation. The electrical apparatus, including the generator, switchboard, pole line and wiring system, was supplied by Allis-Chalmers Bullock, Limited, Montreal. The generator is a 2 phase 2200 volt, 100 k. w., Bullock revolving field type. The power house is equipped with a tandem compounding condensing engine of 160 h.p., built by the Robb Engineering Company, of Amherst, N. S. When the pumps are installed the cost of the building and machinery will be in the neighborhood of $38,000. The whole equipment is thoroughly efficient and modern.

TELEGRAPH and TELEPHONE

TELEPHONE EXTENSION IN WESTERN CANADA.

The Bell Telephone Company contemplate extending their system to reach a number of new towns and villages in Western Canada during the present year. The work already planned is as follows: Along the Glenboro branch wires will be run from Winnipeg to Souris reaching all points on this line. From Portage la Prairie the company will extend their system northwest to Neepawa, through Westbourne, Gladstone and Arden. From Killarney the wires will be run to Deloraine, affording long distance communication to Ninga, Boissevain and Whitewater. Lines will also be built from Winnipeg to Stonewall, from Brandon to Hamiota, from Brandon West to Moosomin, and from Regina to Indian Head, the latter extension connecting Balgonie, McLean and South Qu'Appelle with Regina. In addition to the towns already named, the company will serve the following points not already reached by the service, on the Glenboro branch: Starbuck, Fannystella, Elm Creek, Rothwell, Treherne, Holland, Cypress River, Glenboro, Stockton, Wawanesa, Nesbitt and Carroll. Between Brandon and Hamiota the following important points will be reached: Forrest, Carnegie, Rapid City, Oak River, and Hamiota. West from Brandon to Moosomin, Griswold, Oak Lake, Virden, Elkhorn, Fleming and Moosomin will be reached. A branch line will also be built from Lariviere to Snowflake, connecting south with the American system at Hannal, North Dakota.

If the season will permit, the connecting link between Moosomin and Indian Head will also be completed this year, affording direct connection between Regina and Winnipeg.

The Bell Telephone Company have recently purchased six lots on Henry avenue, running to Fonseca, in Winnipeg. It is the intention to build on this property a stores department, repair shops and stables, the plans for which have already been drawn.

GLASGOW'S MUNICIPAL TELEPHONE SYSTEM.

Of the municipal telephone systems of Great Britain only one, that at Glasgow, has been in operation long enough for the errors of finance and installation to come fully to the surface. The Glasgow system has been in operation for four years. The time is so short that had the plant been all that the ratepayers should have received for their money it should have been to-day in a fairly satisfactory condition. Instead of this the defects are developing with alarming rapidity, and the efficiency of the service has become so greatly impaired that to-day complaints regarding it are very frequent. The defects are not due to the fact that too little money was spent in its installation. The estimate on which it was decided to construct the system called for an expenditure of, without contingencies, £16 14s. per subscriber's line. The 1904 accounts show the average cost per line to have been £30 15s. or over 80 per cent. in excess of the estimate.

The estimates called for all cables being laid in conduits, whereas in the plant as constructed about one-third of the total length of cables is armored cable buried solidly in the ground, hundreds of pounds having thus been saved at the cost of efficiency. This is in itself a serious matter, but it pales into insignificance in comparison with another grave defect. The original installation was on the wall-wire system, a method out of date at the time in all first-class plants. Glasgow discovered this after the money had been spent, and an extension being necessary another system was adopted and then another, and so on, until to-day there are in the various exchanges no less than five different systems employed. Naturally the effect has been complications and a bad service. In the last official report the telephone committee reported that they had under consideration a change in the method of operation, and quite recently manufacturers have been invited to submit estimates on the cost of changing all the central office equipment and subscribed instruments to give automatic calling and clearing. The approximate cost of this change is estimated at £35,000. But at the best this would only mean a patch-work job. To completely reorganize the plant and bring it up to date would require the scrapping of plant that cost about £90,000 and the expenditure of a larger sum.

It would appear, therefore, that Glasgow has spent about twice as much as originally intended, and for the expenditure has a plant that is far from being what it should be.

Early in 1903 the Glasgow municipal plant and the National Telephone Company had approximately an even number of stations. But the municipal service was bad, and growing more and more unsatisfactory, with the result that during the last year the great proportion of new business has been going to the National Company, so that at the present time it has 18,048 stations as compared with 11,822 of the municipal service. The value of a telephone depends largely upon the number of connections that can be secured, and the National being able to give its subscribers 50 per cent. more connections and a better service, the municipal service would appear to be in a more or less precarious position.

SHORT CIRCUITS.

The Bell Telephone Company have opened a new exchange at Virden, Man., with sixty subscribers.

The Bell Telephone Company are installing a new switchboard in their exchange at Prince Albert, N. W. T.

The City Council of Winnipeg, Man., have appointed a committee to report upon the question of establishing a civic telephone system.

Mr. A. Mallory, formerly manager of the C. P. R. Telegraph Company at Calgary, N. W. T., has been appointed circuit manager at Winnipeg. He is succeeded at Calgary by Mr. T. J. Fitzgerald, of St. John, N. B.

The British Columbia Telephone Company, of Vancouver, are endeavoring to secure a franchise in Fernie, B. C., but the council seem to favor the application of a local company represented by Hammond & Turner.

The Bellechasse Telephone Company, of Levis, Que., have applied to the Legislature for power to increase the capital stock to $250,000 and to manufacture and deal in apparatus used in connection with telephones.

The Canadian Machine Telephone Company are installing the underground cables in connection with their systems at Peterboro, Ont. The work is in charge of Mr. P. Melville, Canadian superintendent of the Standard Underground Cable Company.

The Central Dufferin Telephone Association, Limited, of Shelburne, Ont., purpose extending their line about four miles into Amaranth Township, and may also build a line to Black's Corners, a distance of seven miles. Dr. R. W. Rooney is president of the company.

Telephone mistakes may have their serious sides. A man who wanted to communicate with another named Jones looked in the directory and then called up a number. Presently there came through the receiver a soft feminine "Hello!" and he asked: "Who is that?" "This is Mrs. Jones." "Have you any idea where your husband is?" He couldn't understand why she "rang off" so sharply until he looked in the book again and discovered that he had called up the residence of a widow.

The annual meeting of the shareholders of the Central Telephone Company was held at Hampton, N. B., on Jannary 25th. The report of the secretary-treasurer showed that 156 miles of line are being operated, reaching thirty-nine different points in Kings and Queens counties. Plans for further extension and wider operations were introduced and discussed, and it is understood that it was decided to apply for a provincial charter and engage in a general telephone business, special attention to be given to the automatic system. The officers elected for the current year are as follows: President, T. H. Estabrooks, St. John; vice-president, S. H. White, Sussex; secretary-treasurer, H. P. Robinson.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Panel-Boards for Office Buildings.—Systematic arrangement of circuits, avoiding all confusion such as often results in the wiring of large office buildings, is the result of a new type of panel-board installed in the great Railway Exchange Building in Chicago, Illinois. The panel-board is compact, and at the same time gives great flexibility in connecting the various circuits in the building to the metering system. The general arrangement and connections of the device are shown in the accompanying illustrations reproduced from the Technical World. The board is mounted on a shallow steel box and is divided into two sections, vertically (Fig. 1.) At the top the feeders from the three-wire service enter, and are led through the fuses to the main switch. The neutral passes from the switch down to two bus bars in the lower portion

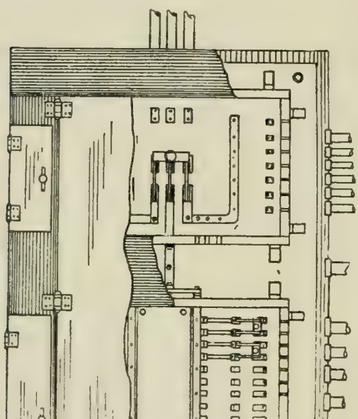


Fig. 1. Panel-Board for Office Buildings. General Arrangement.

of the board. These bus bars are common to one side of each of the office circuits. The other side of each individual office circuit ends in a terminal on the board, and from this terminal a wire is carried up to the customer's meter, the current passing from the meter back to the other side of the main circuit, as shown in Fig. 2. In the latter figure, one of the meters is shown as registering on the two right-hand circuits at the top and bottom of the panel. When the lower one of these offices is to be vacated and the other retained, the meter can readily be changed to the one circuit by merely removing the jumper wire connecting the two, thus disturbing no other wiring.

The wiring of all the meters served by each panel-board is brought in at the sides near the top (Fig. 1), and the lamp circuits lead out opposite their respective switches at the lower portion of the board. The wiring on both sides is identical, although Fig. 1 shows it as entering one side.

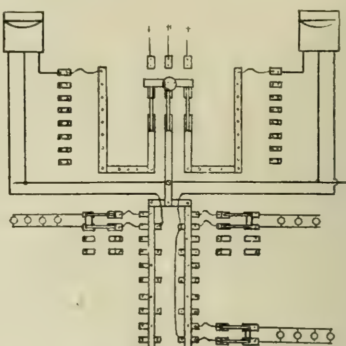


Fig. 2. Panel-Board for Office Buildings.—Connections to Meter.

Unscrewing two marble slabs at the rear, covering the fuses and wiring, gives access to the panel itself. Two small doors at the top and bottom of the case near the edge (Fig. 1) can be opened, to show at a glance which leads are connected to the respective fuses.

Westinghouse Type K Voltmeters and Ammeters.—There has been a long continued demand upon makers of electrical instruments for reliable voltmeters and ammeters for switchboard work in connection with

small installations and in competitive work, that could be supplied at a price in keeping with that of the other apparatus. To fulfill this demand, the Westinghouse Electric & Manufacturing Company offers a new line of instruments known as the Type K for use upon either

direct or alternating currents. This type is a development of one of the Lord Kelvin patents controlled by the Westinghouse Company. In shape, size, finish and general appearance, the Type K instruments harmonize with the other round pattern switchboard types of the Westinghouse manufacture. Their principal distinguishing characteristic is the simplicity of their construction. There are but few parts, none of which are complicated, and the adjustments are easily made. In effect, the mechanism consists of a stationary coil, through which the measured current flows, the voltmeter measuring the current which flows through a high resistance. This coil acts on a movable core or plunger, which is connected with a steel beam mounted upon knife bearings and carrying the indicating pointer. There are no springs, the action being controlled by gravity. In other instruments in which a solenoid is employed, the residual magnetism has seriously affected their accuracy. In the Type K the core is so constructed that it is saturated with a very small amount of magnetic energy, such as that of one twentieth full

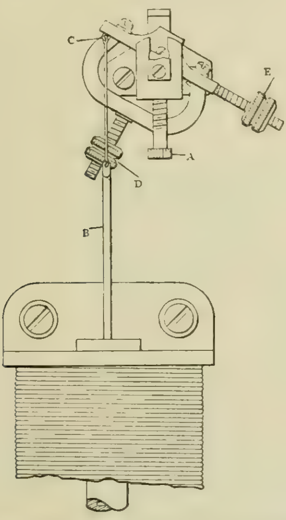


Diagram of Westinghouse Type K Instruments.

scale deflection,and thus for any load the attraction upon the plunger is directly proportional to the current, making the error due to residual magnetism commercially negligible and the scale almost uniform, commencing with zero. On alternating currents its action is not appreciably affected by changes in frequency. External fields do not influence the performance, and temperature errors are negligible. The instruments are dead beat in their indications, the steadying effects of a dash pot being obtained by inserting the lower end of the plunger in a glass tube filled with oil. The opening in the solenoid is made small and the plunger is a piece of fine iron wire, flexibly connected to the movement by means of a strong silk cord. Movable weights shown at D and E in the accompanying illustration afford a means for adjustment. The sector illustrated at A corrects inequalities by keeping the leverage the same in all positions.

New Belt-Driven Alternator.—The General Electric Company, Schenectady, N.Y., have brought out a new form of belt-driven alternator which it designates as form P. The machine is built with two bearings which are mounted one on each end of the shaft. It is of compact design, and occupies less floor space than do machines arranged with separate pillow blocks and bearings. The bearing at the pulley end of the machine is made large, and is placed close to the revolving field spider, in order to bring the pulley close to the machine. The alternator is of the revolving field type with a stationary distributed armature winding. The poles of the field are built up of laminations, and are fitted into dove-tailed slots in the steel hub by taper keys. The field coils are made from flat copper strip, wound on edge, and are designed for 125 volts excitation. The pulley has a cast-iron centre and pressed paper rim. This type of pulley is considerably lighter, and is able to transmit more power per inch of face than an iron pulley, thus tending to increase the life of the belt and to diminish the strain on shaft and bearings.

TRANSFORMER OUTFITS FOR THAWING PIPES.

The manifest superiority of electricity as a thermal agent in thawing frozen pipes, and the field for this service that awaits development, has attracted a considerable amount of attention on the part of central station managers, many of whom have improvised outfits for this purpose. There has arisen a very general demand for thawing outfits that shall have a range in capacity to cover all ordinary requirements, shall be portable, easy to connect and moderate in price, and to meet this demand the Westinghouse Electric & Manufacturing Company have designed the two transformers herein described.

The larger of the two outfits weighs complete with transformer, switchboard and base 750 pounds. It occupies a floor space 2 ft. 4 inches by 1 ft. 10 inches, and is 1 ft. 7 inches in height. A link in the top of the transformer case affords a means of lifting the outfit, and if desired truck wheels may be attached to the wooden base. It will be seen that it is of small size and is lighter in weight than any other outfit for the same purpose, giving it a superior portability.

The transformer may be operated satisfactorily on circuits varying from 1,800 to 2,500 volts. The low tension is arranged to deliver approximately 500 amperes for several hours at an E. M. F. from 15 to 50 volts. By a simple change in connections, the windings may be arranged to deliver about 1,000 amperes at voltages from 8 to 16, for thawing large mains whose resistance is generally low. It is suitable for thawing anything from a one-half inch pipe to a one foot main.

The transformer is generously designed, and will deliver large overloads for short periods of time. The windings are air cooled. The insulation is not injured by rain, snow or ordinary abrasion. There are no moving parts to get out of order, and the entire outfit is contained in a single unit.

A light but substantial switchboard is mounted upon the high tension end of the transformer. The switches are of the enclosed plug type, such as are used upon high tension arc light circuits, and permit a variation of the low tension voltage, and consequently the current supplied to the pipes. The switches are so arranged that it is impossible to make a wrong connection.

The other transformer outfit is smaller and is particularly adapted for thawing service piping about dwelling houses. It is light, of such proportions as to make it easy to handle, and is mounted in a wooden box provided with a handle and shoulder strap. It has a capacity of 200 amperes at potentials up to 25 volts for one hour. It is arranged for operation off a nominal 2,000 volt circuit but can be supplied for any other primary voltage to as low as 200 volts. The voltage regulation and current control are obtained through plug switches in the high tension circuit.

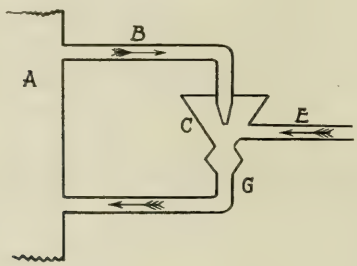
When desired, these outfits are furnished with a current measuring device, so that the operator may know the amount of current that is being used.

ENGINEERING and MECHANICS

THE INJECTOR.*

By F. C. Winterburn.

The injector is a mechanical contrivance by which the energy of a jet of steam from the boiler is utilized to force a stream of water back into the boiler. There are many different kinds of these instruments, but the principle is the same in all. When used for lifting water, the injector depends upon a partial vacuum being created by the jet of steam coming into contact with the cold water. In the accompanying figure this action is



shown. A represents a boiler, B the steam pipe, with a nozzle-shaped end, which discharges into a cone-shaped vessel, C The steam escapes with great velocity through B, and as it passes through C, forcing the air away in its course, the water naturally follows through E, when the steam and water meet. A partial vacuum is formed, then the steam and water rushing into this vacuum-formed space increases the velocity to such an extent that it easily finds its way into the boiler. The injector most commonly used in this district is the Penberthy; other makes are numerous, slightly different in detail, but the principle remains the same in all. To ensure the good working of an injector, it is essential in fitting one to a boiler to follow the following instructions. The steam lead should be as direct as possible and from the part of the boiler where the steam is the driest obtainable; this pipe should have no other connections and should be with as few bends as possible. The suction pipe should be at least one size larger than the nipple on injector, and if the source of supply is far away, two sizes larger is preferable. This pipe must be absolutely air tight, as the slightest leak considerably affects the efficiency of the injector, just as a leaky suction affects a pump.

In long lengths of suction pipe, a non-return valve placed at a convenient distance to break the draw, will be found a great advantage, also a globe valve near the source of supply is a great convenience. A globe valve is placed close to the injector on supply pipe to regulate the water supply. A check valve must be placed on the delivery pipe between injector and boiler, to prevent the return of feed water. A stop cock is also placed between the check and boiler to enable the engineer to examine the check valve at any time when steam is up. The causes that would prevent an injector working are the the following:

1. Leaky suction.
2. Suction pipe stopped up.
3. Dirt in combining tubes.
4. Water too hot.
5. Steam too low.

Each one of these has its own specific remedy, which will readily suggest itself to the engineer in charge; but the best cure, if I may use the expression, is prevention. Each one of these defects can be prevented from causing any inconvenience if the injector is periodically examined and cleaned and all the piping tested. The mechanism of an injector being delicate and sensitive, it should be treated with care and consideration. Scale or dirt in the tubes can be cleaned off either by scraping or soaking in a solution of muriatic acid 1 part, and water 10 parts, and washing properly afterwards before replacing; as it requires 10 to 12 hours in this solution to be of any benefit, I find the former way the handiest. If the scale is not taken away regularly, the full area of the nozzles will not be obtained and the proper flow will be impeded.

When the suction pipe is stopped it can usually be disconnected and cleaned by a rod or by blowing steam through it. The injector should at all times be kept cool, which necessitates the steam valve being always in first class order, also the check valve requires attention occasionally. If these leaks are allowed there is a constant dribble and in waters where there is presence of lime or gypsum, a scale is soon formed on the working parts, increasing the friction and reducing the working area of the injector. If the injector has not an independent steam pipe, other valves may be opened, thus taking away the steam, leaving the instrument with insufficient power to drive it.

One great advantage that the injector has over the feed pump is that most of the heat used to force the water into the boiler is utilized in heating the feed water; the feed entering the boiler at a high temperature saves the boiler plates from injury by sudden contraction, which is often the case where pumps put cold water direct into the boiler, causing leaky tubes, stays, etc. It is also a great fuel saver, by introducing feed water up to the maximum of 150 degrees. The following table gives the average pressures, temperatures and lifts:

Lift in Feet.	Lowest Steam Pressure to Start.	Maximum Temperature of Feed.
0 to 3	15 to 20 lbs.	150 deg. to 140 deg.
4 " 10	25 " 30 "	120 " " 100 "
10 " 20	30 " 45 "	90 " " 75 "
20 " 25	45 " 60 "	80 " " 60 "

The steam at which injectors will work depends on the lift and temperature of water; for a 2-foot lift with 100 lbs. pressure, 145 deg.; for 150 lbs., 130 deg., and 180 lbs., 120 deg. And as the lift increases the temperature of the water must be lowered, the exact temperature being found by practice. The capacity is almost the same in all injectors under like conditions.

Size of Pipe connections.	Gallons per hr. Maximum.	Gallons per hr. Minimum.
3/8"	85	50
1/2"	165	75
3/4"	350	130
1"	580	325
1 1/4"	900	425
1 1/2"	1,750	750
2"	2,850	1,150

*Paper read before the Stationary Engineers' Association, Victoria, B.C.

CERTIFICATES FOR ENGINEERS.

The quarterly examinations for engineers' certificates for the Province of British Columbia were held at Victoria about the middle of January. Of about sixty candidates, the following were successful:

Fourth class certificates—Hy. Puckle, Wm. De Rousie, J A. Sweeney, R. Noble, Thomas Cox, Wm. Freeman, W. Reinhart, A. Carlson, D. Lehman, A. Popham, G. R. Baker, D. Silemult, J. C. Renfrew, A. Berquist, P. A. McLean, R. S. Chapman, G. Underwood, L. Walton, D. Williams, Geo. Ulrich, W. S. Smith, E. Jacobson, C. D. Hawkins, T. J. Carson, T. Cragie, Chas. Cathey and R. Humber.

Third class certificates — James Taylor, J. D. Watson, F. Shade, James Laird, F. Haled, James Tyson, Wm. Graham, A. J. Neff, Wm. D. Thompson, R. D. Stephens, Chas. Hiscock, H. E. Neaves, W. C. Pettigrew, Thomas Preece, H. J. Geake, Joseph Lismore, R. G. Johnston and J. Smith.

Henry Wilson and Peter Gordon secured second class certificates.

A fourth class certificate permits the holder to operate any steam plant up to 25 horse-power; third class enables the possessor to take charge of a plant of 250 horse-power; while the second class permits the holder to be chief engineer of any plant up to 500 horse-power.

The Canadian Association of Stationary Engineers have appointed a committee to wait upon the Ontario Government and again ask that legislation be passed compelling all engineers to hold certificates.

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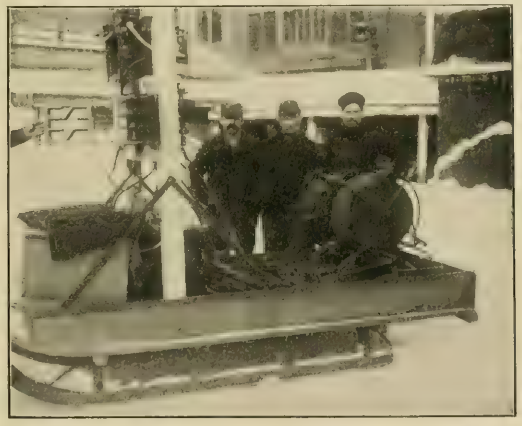
TRANSFORMER THAWING OUTFIT.

By M. A. Sammett,
Of the Montreal Light, Heat and Power Company.

The thawing out of frozen water pipes by means of electricity is a new application which is becoming widespread. Electricity as a thermal agent in this particular use secures best results in the shortest possible time, leaving the pipes intact, making excavations unnecessary and furnishing the cheapest means to restore water supply. While by no means a new method, it is now a necessary adjunct of every electric operating company, and the growing need of transformers with a capacity for heavy currents has forced transformer manufacturers to place on the market special transformers for this purpose.

Prior to the special transformers, it was necessary to use apparatus of very large capacity, in order to be able to obtain heavy currents, so frequently 40 k.w. transformers were used with a water rheostat in series with the secondary coils, thus making the outfit very bulky.



Transformer Thawing Outfit Used by the Montreal, Light, Heat and Power Company.

The Montreal Light, Heat & Power Company, at the present time, has four transformer thawing outfits, of 10 k. w. capacity (normal) load, similar to the one shown in the accompanying photograph. These are doing most effective work. The transformers are of special design made by the writer, with the object of securing full capacity of the transformer at various voltages. So far, the various transformers designed by the leading manufacturers have as a means of regulation either a reactance in series with the secondary coils, or a magnetic shunt on the core, or taps on the secondary winding. In every case, when using a current at a fractional secondary voltage, the transformer capacity is lessened, since the secondary current is a fixed quantity.

In the case of the transformers of the Montreal Light, Heat & Power Company, above mentioned, there are four secondary coils. The start and finish of every coil are brought out to a connection board, and various combinations of the four coils can be obtained. The three switches engage one at a time with the connection board, and the different combinations are obtained, i.e., four coils in series, coils in series multiple, and all coils in multiple. This arrangement will allow the use of full capacity of the transformer with every combination, so in the case of the four coils in series a current of 200 amperes at 50 volts is secured. With the combination of coils in series multiple, 400 amperes at 25.0 volts are secured, and with all coils connected in multiple, 800 amperes of 12.5 volts are available. The primaries are connected on 2000 volt distributing circuits. As the transformers operate intermittently, in an atmosphere of very low temperature, considerable overloads to an extent of double the load are permissible over a period of one half an hour.

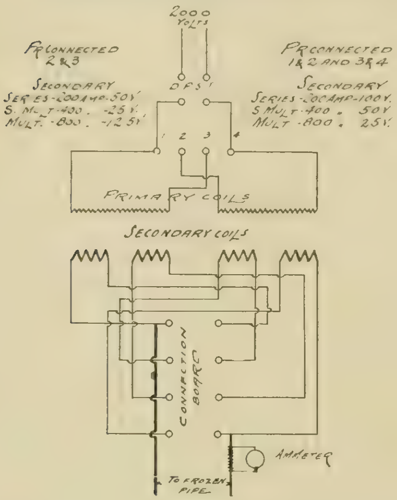
Besides the three combinations on the secondary coils, the transformer is designed so as to allow the placing of the primary coils in multiple and thus enable one to double the secondary voltages for every combination. To secure these results it was necessary to design the transformer with a low magnetic density, keeping the iron at a comparatively low point of saturation. Connecting the primary coils in multiple the following would be the voltages on the secondary side: 100 volts, 50 volts, and 25.0 volts. These voltages give a range wide enough to take in pipes from large mains to small service pipes, and in a number of cases it was found that in the work on service pipes of one-half in. in diameter, and about 200 feet long, the 50 and 25.0 combinations were used with very good results.

In starting the work on thawing out, a switch of the combination of the 50 volts is used first, and as the current comes up to about 200 amperes, this switch is opened and the switch of the series multiple combination

is closed, enabling 400 amperes to be taken off the transformer.

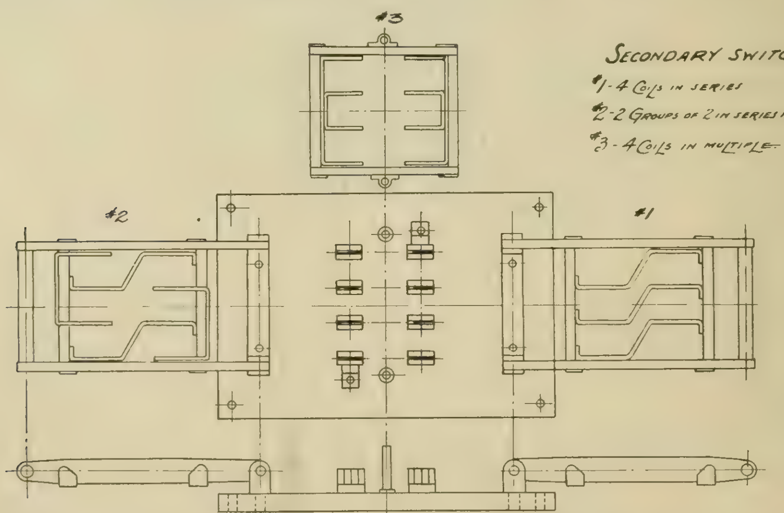
The average time required to thaw out frozen water pipes with this outfit is from two to three minutes, and in one instance a water pipe was thawed out in as little time as fifteen seconds. This commends itself

DIAGRAM OF CONNECTIONS.



very highly as to the efficiency of electric current in this application.

The switch used in connection with these transformers as shown in the sketch is composed of a connection board with eight studs to which the secondary coils are connected. The right and left-hand switches engaging with this board are made of heavy copper bars



and engaging with the board secure the various combinations as mentioned above. The third combination of all secondary coils in multipleis secured by a third switch which is placed in position by the use of two guides.

In the writer's estimation, this method of securing variable voltages is most satisfactory, for the reason that it allows the operator to use the transformer at full capacity, rendering it suitable for work on small service pipes, as well as pipes of large cross section in heavy mains.

HIGH TENSION WIRES.

There has been a lively discussion in the Vancouver City Council on the question of allowing the British Columbia Electric Railway Company to string their high-tension wires on poles along certain streets so as to operate their Lulu Island branch. The Mayor is opposed to such permission. M. J. A. McCrossan, city electrician, has also reported against the privilege, and in a etter to the Council he gives his reasons, which are as follows:

"The city permitted the company's high-voltage wires to be erected upon two streets in the East End two years ago, in order that the company could bring into the city the current generated by the water power at Lake Beautiful. These high-tension wires run to the transformer station on Westminster avenue, where the current of 20,000 volts is reduced to various lower voltages for safer transmission through the streets of the city. It was not the intention either of the city or the company to introduce a high-tension distributing system in addition to that then erected, and I do not think it advisable to establish a precedent for extensions of this character.

"There is no question but what high-tension wires are safe (except to the Fire Department) so long as they remain in place and are thoroughly insulated as intended; but if they drop or become crossed with other wires, then it all depends upon the conditions of the case as to what damage may result to life or property.

"In the first place, it is unnecessary for me to dilate upon the power to destroy life, and on the other hand, let me suppose a case occurs with the Street Railway system, either through a feeder wire or trolley. The tendency of electrical currents is to get to earth by the shortest route, and paths are already made for it through the street cars, resulting in firing the cars and possibly killing the crew and passengers. On the other supposition of a cross occurring with the lighting system, this current carried into the buildings and grounding on water and gas pipes would ignite all buildings that it passed through.

"Naturally the current would be cut off as quickly as possible upon anything going wrong, but electricity acts so quickly that the damage is done before safety measures can be put into operation.

"My final reason is that refusing permission does not in any way block the company's project, as it can accomplish the same results by keeping its wires outside the city limits entirely, the latter, however, entailing some additional expense to the company.

The Council, notwithstanding the above report, seem likely to grant the company's request.

AFFECT OF LOAD FACTOR ON COST OF POWER.

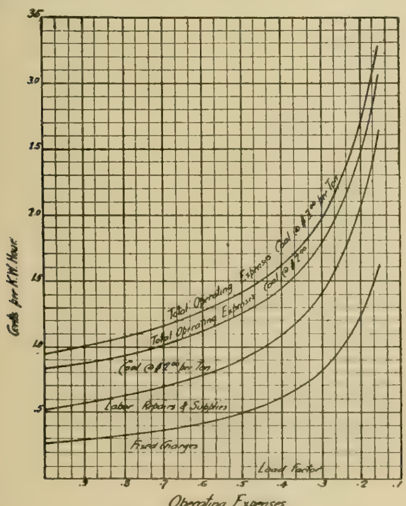
By E. M. Archibald B.Sc.

The great desideratum for an electrical system is a high load factor with consequent greatest return on investment; load factor being the ratio of average to maximum load. All the factors of expense included in cost of power to the consumer are then operating at maximum economy, and cost of power is at a minimum.

The ligthing of residences and offices produces a peak in the ate afternoon and evening, with but little load the remainder of the twenty-four hours; consequently the average load on the plant with lighting only is very small and the load factor low. A commercial motor load in connection with lighting will increase the average load even though causing a greater peak. The addition of a street railway load still further increases the day load, but in consequence of the heavy demand load during the rush hours, when the public is going to and from business, which occurs at the peak of the lighting load, the peak load on the plant is greatly increased. This heavy peak, with but a small average load over the twenty-four hours, produces a low load factor, and a portion of the machinery being shut down the greater part of the time, higher rates must be paid by the consumer to secure a certain return on first investment than when the load factor is higher.

Evidently when the load factor is 100%, that is when the load is constant throughout the twenty-four hours, and all the machinery is in continuous operation, the cost of power per K.W. Hr. is a minimum, and the greatest return on investment is realized. Customers having a steady load or with high average load are greatly desired and may be offered much better rates than all others. It will be the endeavour of this paper to determine the decreased cost of power with increasing load factor.

The storage battery is evidently a means in the hands of the power producing company of increasing the average load on the machinery. By charging the battery during light load and discharging during periods of heavy load, a more constant load on the generating apparatus is produced, with consequent better efficiency, and at the same time acting as a reserve in case of accident in the power plant. Unfortunately the battery is expensive, and a loss occurs in its operation which greatly reduces the higher efficiency secured by the increased load factor. The great benefits obtained by its use are reserve capacity and voltage regulation, enabling the use of more efficient lamps.



Operating Expenses of 900 K.W. Condensing Steam Plant - Peak 750 K.W.

Fig. 1

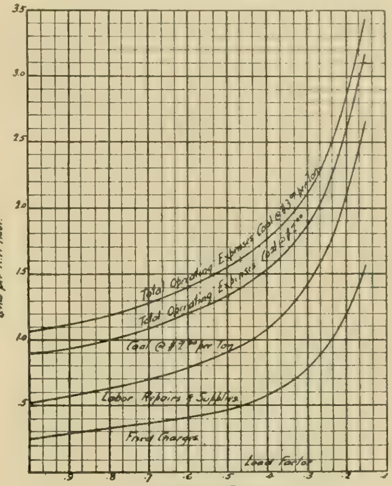
The storage battery, however, has not been considered in what follows, even where it might be desirable, but rather a plant is assumed of certain maximum capacity for the peak load, and we are to determine what effect various load factors have on the cost of power produced.

The various expences involved in the cost of power to the consumer are as follows: (1) management; (2) distribution; (3) production.

Paper read before the Canadian Society of Civil Engineers, January 25th, 1905.

For a given system with given peak load the cost of management is practically constant, no matter what the load factor.

The cost of distribution is constant with various load factors in so far as the fixed charges and maintenance is concerned. The losses in distribution, however, vary, these consisting of losses in lines, transformers if alternating current is used, meters, losses in grounds and losses from theft of current ; all decrease the output and accordingly increase the cost to the consumer. While it is possible to determine fairly accurately the losses in lines, transformers and meters with varying load factors, the losses from grounds and theft are indeterminate and require constant attention to keep them within certain limits. Yet as a rule these latter will become a smaller percentage of the total output the higher the load factor.



Operating Expenses of 900 K.W. Non Condensing Plant - Peak Load 750 K.W.

Fig. 2

There yet remains for consideration the effect of the load factor on the actual cost of production of energy.

The higher the load factor, the greater is the amount of power produced, the longer does the apparatus operate most efficiently, the lower the ratio of fixed charges to total operating expenses, and consequently the lower the cost of power per unit.

To determine exactly in what proportion the cost of power is decreased, it will be necessary to assume a plant, determine the fixed and variable charges and thereby the cost per K. W. Hr. at various load factors.

Let us take for example a plant with a peak load of 750 K. W. Allow three units of 300 K. W. capacity each, so that in case of a break-down to one, the other two may take care of the peak, with an overload of 25% on each and sufficient boiler capacity for the same contingency. No provision is allowed for stokers, coal handling apparatus or economizers. Plant assumed to be on the water front providing sufficient water for condensing purposes.

Curves are also plotted for a second plant of the same capacity as the first, but operating non-condensing. In both cases either water or railroad connections assumed with convenient facilities for coal handling and removal of ashes.

First cost of plant complete :—

Condensing, $118,425.00 equivalent to $131.60 per K. W.

Non-condensing, $114,625.00 equivalent to $127.40 per K. W.

Fixed charges.	Condensing.	Non-Condensing.
Interest at 5%	$5,921.25	$5,731.25
Taxes and insurance at 2%	2,368.50	2,292.50
Depreciation machinery 10%	7,710.00	7,305.00
Building 3%	1,122.00	1,134.00
Total	$17,121.75	$16,462.75

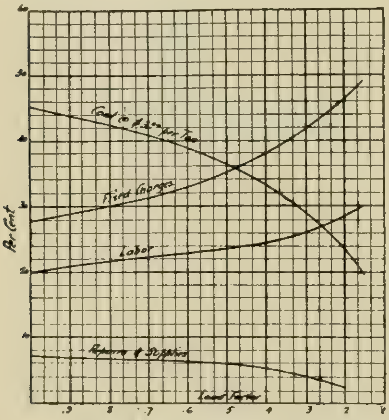
The above first cost being for 100% load factor, there will be a varying reduction due to the decreased boiler capacity required on lower load factors. A point is reached below where it is not advisable to further decrease the boiler capacity as the peak load must be taken care of and sufficient reserve provided for

accidents and repairs ; this point being taken in this case at 40 load factor. The effect of this reduction is to diminish the fixed charges at 40% load factor by $1,000.00 per year, or about 6% of the total. From these figures the lower line in figs. 1 and 2 are plotted and indicate the effect of fixed charges on the cost of power.

The remaining items of expense are what are generally termed operating charges and are variable with load factor. These consist of (1) labor,oil and waste,supplles,water and repairs; (2) fuel.

The cost of labor varies to a certain extent with load factor, but a minimum number of men required to operate the plant is reached at about 40% load factor, below which this item remains constant. The cost of oil and waste, supplies, water and repairs varies almost directly with load factor as the greater number of hours per day that the machinery remains in service, the greater do these expenses become, and vice versa. The second line in figs. 1 and 2 is for ihese charges reduced to the K. W. Hr. basis and is added to the fixed charges curve ; the difference between the two curves therefore represents the cost of labor, oil and waste, supplies, water and repairs.

The cost of fuel, usually coal, per unit of power generated, varies with some power of the load factor less than one depending upon the number and efficiency of units employed both in the engine and boiler rooms, also upon the cost per ton of coal, its heating value, and upon the ability of the firemen to get the best results ; it is of the utmost importance to watch this item carefully, as greater economy can be secured in the cost of coal per K. W. Hr. than in any other item of expense. The calorific



Ratio of Individual Items of Operating Expenses to Total Operating Expenses
900 K.W. Condensing Steam Plant - Peak 750 K.W.
Fig 3

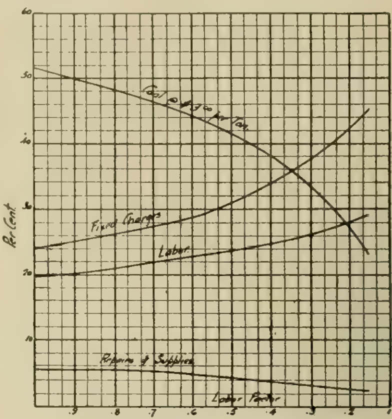
value of the coal should be tested from time to time and compared with the number of lbs. used per K. W. Hr.

The coal considered is assumed to contain 12,000 B.T.U.'s per lb., and two curves are plotted in figures 1 and 2 when the cost is $2.00 and $3.00 per ton respectively, the results being added to the two previous curves plotted. These figures of fuel cost per K.W.Hr. are above the average usually obtained and can only be secured by constant attention in the boiler room ; for instance at 40% load factor in the first case 1 K.W.Hr. is generated from 3.5 lbs. of coal from the pile.

The ratio of the individual items of expense to total operating expense is shown by figs. 3 and 4 for the condensing and non-condensing plants respectively with coal at $3.00 per ton delivered. It is interesting in this connection to note the high percentage of fuel cost ; in the average plant this percentage will be still higher than that shown, but this indicates how great a factor is the cost of fuel particularly with high load factors. For low load factor the fuel is subordinated by the fixed charges, which is by far the heaviest item.

Having thus determined the cost of power for a plant with a peak of 750 K.W., we shall consider briefly a larger plant and ascertain what extra economies may be secured. This plant we shall assume to have a peak load of 1,500 K.W. and a maximum capacity of 1,800 K.W., divided into three units of 600 K.W. each. Stokers are used, but no economizers or coal handling apparatus ; the boilers are in a single line parallel to the engine room, and coal is dumped from the car into a chute, whence it falls to the floor of the boiler room.

First cost of this plant at 100% load factor is $241,125.00, equivalent to $134.00 per K.W. Fixed charges, using the same per cent. for interest, depreciation, taxes and insurance as in the previous case become $36,318.75 per year. Curves are plotted in fig. 5 for fixed charges, labor, supplies and repairs, and fuel,

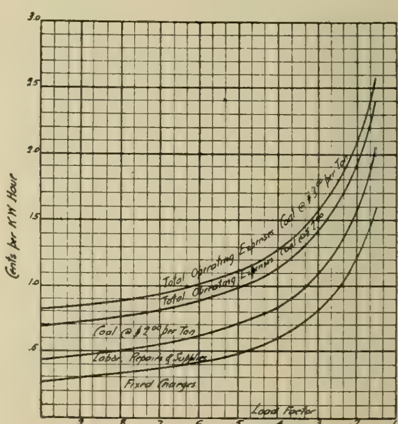


Ratio of Individual Items of Operating Expenses to Total. Operating Expenses.
900 K.W. Non-Condensing Steam Plant - Peak 750 K.W.
Fig. 4

the latter being plotted for the two prices $2.00 and $3.00 per ton as before.

With all these curves before us it might be well to make some deductions as to the advisability of further expenditures in the power plant in coal handling apparatus and economizers, or in general, any apparatus that tends to increase the economy.

The higher the load factor the greater becomes the ratio of variable to fixed charges, and extra investment is advisable to secure the greatest economy possible. Extra investment in coal handling apparatus and economizers will reduce the cost of



Operating Expenses of 1800 K.W. Condensing Steam Plant - Peak 1500 K.W.
Fig. 5

labor and fuel in greater proportion than fixed charges are increased ; the economizers also provides greater boiler capacity and purer feed water, reducing cost of repairs.

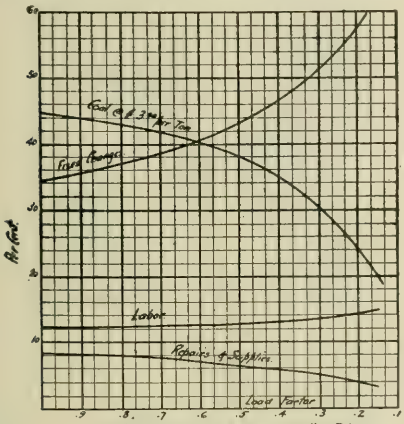
On the contrary when the load factor on a system is low, the fixed charges are the governing factor in the cost of power, and extra expenditures must be carefully considered, particularly so if fuel is cheap.

Having thus discussed the effect of load factor on the cost of producing power, we shall next turn to the cost of management and distribution. While it is beyond the scope of this paper to

fully consider these costs, yet it was thought advisable to indicate by a curve including all the various costs approximately, how the load factor influences the cost to the consumer. This is done very generally, as no two cases are alike ; the cost of distribution is more variable with different systems than is the cost of power, depending on the conditions of distribution, conduit or pole line construction and the extent and density of the territory to be covered.

We shall allow that $50,000.00 per year covers all fixed charges, maintenance and attendance on the distributing net work ; $35,000.00 per year for management, dividends on stock and miscellaneous expenses. For total losses 30% of the output is allowed ; this is taken constant for all load factors, for while the percentage of known losses varies directly with load factor, the percentage of indeterminate losses by grounds and theft varies inversely as the load factor. The actual losses from grounds are constant, hence percentage loss by grounds varies inversely as load factor ; losses from theft usually occur with customers having a short hour load, and the greater the amount of such load connected, the greater this loss. A customer having a long hour load runs a greater chance of detection than others. Hence, the above statement holds that the total percentage loss will be constant. Further, this lost power reduces the amount of sales, therefore affecting all the expenses included in cost to customer.

Fig. 7 shows a series of curves plotted for the 1,800 K. W. steam plant, the lower line representing cost of production; the



Ratio of Individual Items of Operating Expense to Total Operating Expense.
1800 K.W. Condensing Steam Plant - Peak Load 1500 K.W.
Fig-6

second, cost of distribution ; third, cost of management, and fourth the effect of distribution losses on cost of power, this last being the final cost to consumer.

Coal is expensive, and from the nature of things will increase n price, and it behooves us to investigate any method of producing power which is more economical in the use of fuel than the steam engine, and naturally turning to the gas engine we will next proceed to make a comparison between a steam plant and a gas plant generating producer gas for use in gas engines, and from such comparison deduce some general results.

As is well-known, the gas engine has a very much higher thermal efficiency than the steam engine, which fact, together with the fewer number of auxiliaries required, would naturally lead one to suppose that a greater economy could be secured in the production of power.

Difficulties, however, are encountered at the outset in the kind of fuel that may be used successfully in the gas producer. While the gas generated from anthracite coal is very successful in the operation of gas engines, the gas from bituminous coal contains tar which, when carried through the valves into the cylinders of the engine, clogs the valves and carbonizes under the intense heat to which it is subjected in the cylinder, preventing successful operation. Some manufacturers claim to have succeeded in removing the tar or preventing its formation, but the burden of proof still rests with them.

The overload rating of the gas engine is different from the steam engine in the ratio of about 15 to 50 per cent. Hence in designing two plants, steam and gas, for equal overload capacities it is necessary either to use gas engines of 25 to 35 per cent. higher normal rating, with consequent poorer economy at normal load; or add an extra engine and generator sufficient to take care of the extra overload capacity of the steam engine over the gas engine. For example, in designing a gas plant of 900 K. W. capacity with a peak load of 750 K. W., allowing the same reserve as in the steam plant considered previously, three engines

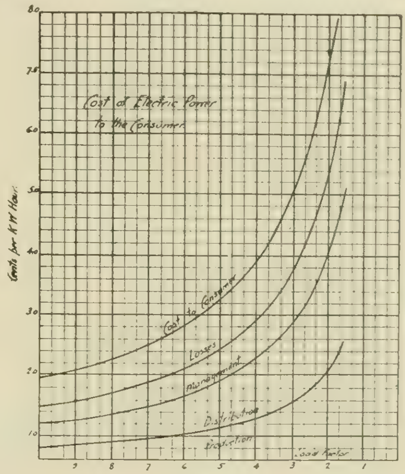


Fig-7

of 530 B. H. P. each will be required with an aggregate normal B. H. P. of 1,590 and maximum B. H. P. of 1,830, as compared with three 450 I. H. P. equivalent to 410 B.H.P. engines aggregating 1,230 normal B. H. P. and 1,830 maximum B.H.P. ; or three gas engines of 410 B.H.P. each and an additional engine of 360 B.H.P. aggregating 1,830 B.H.P. on maximum load (from a practical standpoint, this additional engine would be made of the same capacity as the rest, the cost being the same). In the first case at normal load on the generators the engines are 30% under loaded with consequent poor efficiency ; in the second case

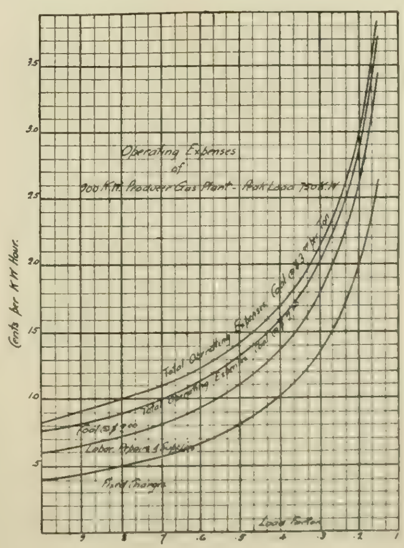


Fig. 8

the first cost will be greater, due to the extra generator and increased size of building required.

Allowing the same reserve capacity in producers, and with three 530 B.H.P. gas engines direct connected to 300 K. W.

generators running at 100 r.p.m., the first cost becomes $167,650, equivalent to $186 per K. W.

Fixed charges :—

Interest at 5% on $167,650	$8,382.50
Depreciation on machinery 10	13,340.00
Depreciation on buildings 3	1,005.00
Taxes and Insurance 2	3,353.00
Total	$26,080.50

The storage capacity at 100 load factor is small, about 20,000 cubic ft., and is provided more for uniformity of gas than for storage. In case of accident to one producer, a second may be under way producing gas inside half an hour. The question of storage is important, particularly at small load factors when storage may be provided for the peak and a constant load maintained on the producers. In a plant of this size where the number of producers actually required is not over two with a third for reserve, it is more advisable to use the same number of producers for all load factors and a small amount of storage for uniformity of gas and sudden peaks. Further, the extra storage capacity required for small load factors costs about the same as an extra producer.

The operating costs for oil, water, repairs, supplies and water have been taken practically the same as for steam, as there is insufficient reliable data at hand on this subject at the present time.

Cost of labor is somewhat cheaper for the type of producers considered only one man is actually required.

In fig. 8 are given curves for cost of power with varying load factor for this 900 K.W. gas plant.

A comparison of fig. 1, 2, and 8 shows a greater economy for the gas plant at the higher load factors, but poorer economy at low load factors due to the influence ot the heavy fixed charges.

The higher the cost of coal the greater is the economy of the gas over the steam plant at high load factors.

It must be remembered that the fuel economy in the case of the steam plants is taken considerably higher than the average and can only be secured by constant and careful attention to all the details around a power plant ; in the gas plant the fuel at 50% load factor is taken at 1.4 lbs. coal per B.H.P.Hour, which is somewhat higher than the manufacturers will guarantee. No matter how the fuel costs may vary from those given in these curves, they are relatively of far greater importance when the load factor is high than when it is low.

FEDERAL COURT SUSTAINS TESLA PATENTS IN SYNCHRONOUS MOTOR SUIT.

In pursuance of a decision handed down by him on February 20th, in the United States Circuit Court for the Eastern District of Wisconsin sustaining the contention of the Westinghouse Electric & Manufacturing Company that the synchronous motors of the National Electric Company were an infringement of the broad rights covered in Tesla patents Nos. 381968-381969-382280 and 382281, Judge Seaman, in Milwaukee on February 24, enjoined the National Company from the further sale of such motors. The decision in the suit is the first that has been obtained in the litigation begun some time ago by the Westinghouse Company to prevent the sale of synchronous motors and rotary converters by American manufacturers not enjoying a license under the Tesla polyphase motor patents. The hearing in the suit against the National Electric Company was conducted before Judge Seaman on February 6th and 7th, Mr. Thomas B. Kerr and Mr. Parker W. Page appearing for the Westinghouse Company. A decision is now pending in the United States Circuit Court for the southern district of Ohio in the suit brought by the Westinghouse Company against the Bullock Electric Manufacturing Company, alleging similar infringement of the same patent rights in the sale of Bullock synchronous motors and rotary converters. The final hearing in the latter suit was conducted before Judge Thompson in Cincinnati on February 7th and 8th, Mr. Frederic H. Betts and Mr. Page appearing for the complainant.

The Tesla patents involved in these suits have been the subject of considerable litigation in the past few years. The action instituted by the Westinghouse Company a number of years ago against the Thomson-Houston Company, for alleged infringement of the Tesla patents, was discontinued upon the execution of a patent agreement under which the General Electric Company has for several years manufactured and sold induction and synchronous motors and rotary converters. A number of manufacturers have been enjoined from manufacturing induction motors, but the decision in the suit against the National Electric Company is the first court ruling that the synchronous motor is within the generic Tesla invention.

THE ONTARIO MUNICIPAL POWER COMMISSION.

The Municipal Power Works Act of 1903 conferred upon municipalities in Ontario the right to engage in the development and sale at cost price of electric power. The municipalities of Toronto, London, Guelph, Woodstock, Brantford, Stratford and Ingersoll have taken advantage of the power conferred upon them by the Act and have appointed a Commission to report upon the best mode of development and transmission and of the cost of the same, the object in view evidently being the utilization of Niagara power. The Commissioners have appointed Messrs. Ross & Holgate, electrical and hydraulic engineers, to carry out the field engineering work. Mr. R. A. Ross, who was a member of the Commission, has therefore resigned, and Mr. Reginald Aubrey Fessenden, who is at present

MR. R. A. FESSENDEN, E.E.
Member of the Ontario Municipal Power Commission.

resident in Washington, D.C., has been appointed to the Commission as consulting electrical engineer.

Mr. Fessenden, whose portrait appears herewith, was born in Milton, P.Q., October 6, 1866. He was educated at Trinity College School, Port Hope, and in 1886 and 1887 was inspecting engineer for the Edison Company of New York, and for the following three years was head chemist in the laboratory of Thomas A. Edison. From 1890 to 1892 he was employed at Newark, N.J., as electrician for the Westinghouse Electric & Manufacturing Company, and in 1892-3 was professor of physics and electrical engineering in Purdue University. From 1893 to 1900 he was professor of electrical engineering at the University of Pennsylvania. Recently he has been engaged as a consulting electrical engineer in Washington.

Mr. Fessenden is the author of many valuable articles relating to the science of electricity. Of these we might mention a paper on "Conduction and Insulation" read before the American Institute of Electrical Engineers in 1898 ; "Electro-Magnetic Mechanism with Special Reference to High Speed Telegraphy," Franklin Institute, 1899 ; "Wireless Telegraphy," American Institute of Electrical Engineers, 1899 ; and "Nature of Inertia and Nature and Velocity of Gravitation," Electrical World & Science, 1900, also about sixty other papers.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. NO. 1.—In a water wheel catalogue that I have, the power of a thirty-nine inch wheel is given as 102 horse-power with a ten foot head. With a head of twenty feet, the power of the same size wheel is 290. How is it that when you double the head you get about three times the horse-power? What is the exact relation and how is it got at? Also I notice that with ten feet head, the speed of the 39″ wheel is 138 revolutions, and with twenty feet it is 195. In the first case the wheel uses 6,679 cubic feet of water per minute, and in the last case 9,450. What is the relation between the two speeds, and the amount of water?

ANS.—For simplicity, we will take up the latter questions first. When water is being discharged through an orifice, say one square inch in area, it leaves that opening, when the head is ten feet, with a speed of 1,521 feet per minute. The amount of water discharged under these conditions will be 10.57 cubic feet per minute. Now, if the head be doubled, or made twenty feet, the velocity will be 2,152 feet per minute, and the discharge 14.95 cubic feet. These figures are theoretical altogether, but in practice they are checked fairly closely. It will be seen that if the head be doubled, or multiplied by two, then both the velocity and the discharge are multiplied by 1.41 or the square root of 2. In a water wheel the peripheral speed will always be somewhat below the theoretical velocity of the water. For instance, for the 39″ wheel, the circumference is approximately 10.2 feet. At 138 revolutions the peripheral speed will be 10.2 x 138 or 1,407 feet per minute with a ten foot head, and for this head, the theoretical velocity of the water as already mentioned is 1,521. Now, if you double the head, you increase the water velocity by 1.41, and hence the speed of the wheel will be increased in the same proportion. 138 x 1.41 is 195. The quantity of water varies in the same way. 6,679 (for ten foot head) x 1.41 is 9,450 (for twenty foot head). In other words, the speed of the wheel, and the water used, vary as the square root of the number by which the head is multiplied. Now to take up the first question. If the 39″ wheel gives 102 horse-power with ten feet head, it will give 204 horse-power with twenty feet head, provided the quantity of water per minute is the same with each case. But with the increased head the water used will increase by 1.41, as previously shown. Therefore, to find the power which the wheel will give with twenty feet—102 h.p. x 2 (for the doubled head) x 1.41 (for the increased water) equals 290. Expressed simply, the power of a wheel increases as the square root of the cube of the number by which the head is multiplied. For example—when the head is changed from ten to twenty feet, it is multiplied by 2. The cube of 2 is 8. The square root of 8 is 2.83. Therefore 102 (horse-power for ten feet) x 2.83 equals 290 (horse-power for twenty feet).

QUES. NO. 2.—What changes would be required to make a standard 6 ampere 104 volt alternating current enclosed arc lamp operate (a) without an inner globe; (b) in a horizontal position; (c) what number of hours would one pair of carbons last without the inner globe; (d) what is the temperature in °C of the arc of such a lamp; (e) what would be the temperature (approximate) say one-eighth inch from the carbons, parallel with the arc; (f) could an electric arc blow-pipe be used on such a lamp with a view of using the arc for a high temperature?

ANS.—(a) Practically no change in the lamp mechanism itself. Possibly the connecting wire to the lifting magnet might have to be shifted to one of the other taps, and the arc voltage changed by means of the compensating coil, but if any readjustment be required at all it will not amount to much. (b) In order that the lamp be automatic the friction of the moving parts must be very low. In a vertical or normal position, this friction is small, and does not interfere with the operation of the parts, but if the lamp were placed horizontal, a considerable amount of friction would be introduced. It is doubtful if this could be sufficiently eliminated in a standard lamp so as to make the movements smooth and gradual. When the lamp is vertical the pull of the solenoid has to overcome the force of gravity which acts on all the moving parts. With the lamp horizontal the gravity element would be done away with, and therefore some means would have to be provided to produce a pull of the same magnitude towards the base of the lamp. (c) Somewhere about ten hours with a twelve inch trim. (d) Authorities differ as to the exact temperature of the arc, etc. For a direct current lamp the positive would be about 3500°C, based on given averages, and the negative 2500°C. For the alternating lamp the temperatures would be about the same for both carbons, probably an average of the two just given. The temperature of the arc itself will be lower than that of the craters. We presume that it will be somewhere about 2,000°C to 2,500°C. (e) One-eighth inch away from the arc the temperature will be about one-half of that of the arc itself. When dealing with such great heats, it is very difficult to get correct figures. The arc is constantly moving and is therefore very hard to measure. (f) When even a feeble current of air is projected against an arc, the arc is immediately blown out. We are therefore of the opinion that you cannot make use of it for a blow-pipe. In a certain "arc welder" the carbons are brought together at a sharp angle, and a small electro magnet is placed close to their points. This magnet bends the arc outward to a small extent, making it possible to apply it direct to any object. Such a scheme as this would probably answer the purpose of an "arc blow-pipe."

QUES. NO. 3.—How much does water weigh, and how is the horse-power of a water fall calculated?

ANS.—The weight of one cubic foot of water is approximately 62 lbs. To get the horse-power, the quantity of water in cubic feet per minute which passes over the fall must be ascertained. This can be found by various methods. The cross sectional area of the stream, times the speed of the water at the centre of the top, times the constant .85, is probably the simplest formula. Then cubic feet, times weight of one cubic foot, times the height of the fall, will give the foot-pounds. This divided by 33,000, the number of foot-pounds in one horse-power, will give the theoretical horse-power of the fall. About 70% of this amount can be converted into mechanical motion, the balance 30% being lost in the wheel, the head race, and the tail race. The formula is simplified as follows:—.00132 x Q x H equals H. P. which can be obtained; Q being cubic feet per minute, and H the head in feet.

SNOW CLEARING IN OTTAWA.

By J. E. Hutcheson,
Superintendent Ottawa Electric Railway Company.

Fifteen years ago it was generally considered impossible to operate an electric railway in Eastern Canada because of the snow problem, and when the subject of a service in Ottawa was first mooted many capitalists refused to risk their money in a project which presented to them such insuperable difficulties. The promoters themselves were not over sanguine and had a clause embodied in the agreement with the City which provided for the substitution of sleighs drawn by horses for electrically propelled cars.

Albert Street, Ottawa, Looking West, After the Storm of January 8th.

When I was drafted from the Canadian Pacific Railway in 1891 and placed in charge of the construction, and later, the operation of this, the first electric street railway in Canada, I must confess I had some misgivings as regards winter operation. Fortunately the devices and methods employed proved successful, and after two or three years, the period of transition, these were improved upon, and have since been adopted and made standard in all cities in Canada. Few people, however, outside of those in the business, realize how formidable is the task of keeping street railway tracks clear of snow, let alone that of disposing of it after it is removed from the rails. Even to those of us familiar with winter railway operation in this part of Canada, the results accomplished are surprising.

The layman asks, "How have the winter battles of the past fourteen years been fought and won?" My answer is, had parsimony been the policy of the directors, or had intelligence, loyalty and co-operation been wanting in our employees, failure might easily have taken the place of success. Marvellous and useful as are the inventions, little can be accomplished in successfully performing a great public duty without the co-operation of officers and men.

Within the limits of such an article as this I will not attempt to describe the characteristics of the many devices used by the Ottawa Electric Railway Company in snow clearing, and will do no more than enumerate.

For the information of the reader who may not be familiar with our system, I may say that in winter months we operate cars on eighteen miles of city streets, or thirty-six miles of single track. According to our agreement with the City of Ottawa we are obliged to remove all snow from the streets upon which we operate, including that thrown from the sidewalks and what slides from the buildings onto the streets, leaving what the City Engineer decides is sufficient for sleighing. This he has determined to be six inches.

The snow clearing equipment consists of ten rotary broom sweepers, three electric wing-ploughs, fifteen horse wing-ploughs on wheels, and one hundred snow boxes $12' \times 4' \times 4'$. Many cars are equipped with track scrapers and steel wire track brushes.

The sweepers were manufactured by The McGuire-Cummings Manufacturing Company of Chicago and by The Ottawa Car Company, Limited, Ottawa, Ontario. The electric wing-ploughs were designed by the writer and constructed in the shops of the Company, and since they were first put in service two years ago it has not been necessary to use the horse ploughs, so that all the snow clearing is done by electrical machinery, and the removal from the streets by horses. This latter practice, apart from the difficulties we have had in controlling an irresponsible lot of teamsters, works very satisfactorily. A scheme for the removal of snow by large dump cars hauled on the tracks by an electric motor has been given a great deal of consideration. Such a method may be feasible, but many difficulties must be overcome before it can be successfully carried on. Whether or not the horse and sleigh

Removing Snow From the Street by The Ottawa Electric Railway Company.

for this work must some day disappear, or whether the hopes of those who favor the more artistic method of removal by cars will some day find; fulfillment, I am not rash enough to predict. In my opinion, under present conditions the system in force is the most practical, as no elaborate equipment is required and the work goes on by day without interfering with the car service.

In the early history of the Company the winters were

comparatively moderate, consequently heavy snow falls were easily handled. Conditions have changed, however, and the winters of the past few years have been very severe, the heavy snow falls being accompanied by intense cold weather and high winds. The winter of 1903-04 was a terror, the worst ever experienced in this section of the country (the "Oldest Inhabitant" is authority for this statement), the snow fall amounting to 109.75 inches.

Notwithstanding the severity of the winter we were able to operate all our lines daily without serious disorganization.

Snow Sweeper and Electric Wing-Plow Used by The Ottawa Electric Railway Company.

In this district east winds in winter are always a warning of a heavy snow fall, and we have learned that the only way to fight such storms successfully is to start the full battery of sweepers out the moment the snow begins to fall, each sweeper having its own route, the men in charge being the oldest and most experienced in the service. After the sweepers have been at work a short time the three large wing-ploughs are sent out and remove the loose snow back to the curb, piling it up ready to be drawn away. The wings of the ploughs are operated by a competent man inside the cab, and will clear the snow back for a distance of eleven feet from the rail. As soon as this work is completed the work of removing the snow from the streets begins, the business section receiving first attention. The one hundred teams are divided into three gangs, a central, western, and eastern, and the snow is carted to several convenient dumps. The Company supplies only the boxes and men to load and unload. The contractors own the horses and sleighs (bobs) and receive twenty cents per load of, approximately, eight cubic yards.

Snow Box Used by the Ottawa Electric Railway Company.

The superficial area of the streets from which snow has to be removed is 526,271 square yards.

During the winter of 1903-04, 312,000 cubic yards of snow were hauled.

The actual cost of sweeping, ploughing, loading, unloading, etc., is $21,700, .8558 cents per car mile, approximately seven cents per cubic yard, or $600 per mile of single track. This item alone makes up about 10 per cent. of the total operating expenses for the year. The present winter, 1904-05, bids fair to equal, if not surpass, in severity and expense that of 1903-04. The storm of January 7-8, when twenty-four inches of snow fell, came with unusual violence, the wind blowing forty miles per hour with the temperature 10° below zero. The cost of clearing up after this storm amounted to nearly $12,000, and the total expenditure for the winter to date has reached $16,000.

Ottawa, Feb. 20th, 1905.

STEAM TURBINE PLANT IN KLONDIKE.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., have just entered an order for the equipment of a power house for the electrical operation of gold dredging boats on the Alaskan rivers. The plan is an entirely new one and involves many interesting features.

A number of Detroit capitalists recently formed the Canadian Klondike Mining Company. A visit was made to the works of the Westinghouse interests at East Pittsburg to ascertain if electrical machinery could be used in the gold mining plant. After considering various plans, it was decided to install a 400 kilowatt turbo-generator in the power house, to be driven by a 600 horse-power Westinghouse-Parsons steam turbine. The dredge boats are being built by the Marion Steam Shovel Company, of Marion, Ohio. On these boats will be installed induction motors aggregating a total of about 500 horse-power, and varying in size from $7\frac{1}{2}$ to 100 horse-power.

The fact that these people are willing to install a plant of this nature in such a distant country, far from the manufactory and possible repairs, show the confidence engineers place in this type of unit. The power house will be located at Dawson City, and the dredges will operate on the Yukon river and its tributaries. Lines for transmitting power will be strung from the station to the boats, wherever they may be working. Electrical machinery is used very extensively in mining operations, but this plant will be watched with considerable interest, owing to the remoteness of the country and the new field which will be opened.

Mr. James Galloway has finally transferred his electric light plant at Thamesville, Ont., to the corporation.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Niagara Power and Toronto

The starting of one of the large generators in the power house of the Canadian Niagara Power Company on the second day of the new year, marks an important epoch in the production of electrical energy in Canada. This is the first power house to be put in operation on our side of the Falls, and it is not only possible but also probable that before we bid good-bye to the present year the two other power plants will be producing current. So far as the City of Toronto is concerned, Niagara power will be delivered there just as soon as the transmission line is completed. Work on this structure is now being hurried with all possible speed, and the engineers hope that the structure will be ready for work within a very few months. For the total of seventy-five miles, perhaps two-thirds of the steel towers are now in place, and when the balance are installed, not many weeks will be required to string the wires. By the time the line is ready, arrangements will have been made in the sub-stations to take care of a considerable quantity of energy, and as the power house of the Electrical Development Company will not have reached completion by that date, arrangements have been made to purchase from the Canadian Niagara Power Company such current as they are in position to supply.

Conversion of Energy.

There came to our office recently a very interesting table showing the amount of heat in one pound of coal, and the percentage of this energy which is lost in the conversion into mechanical motion. In the plant from which the figures are taken, the generators are direct-connected to the engines, and all power delivered from the engine room is in the electrical form. For reconverting it into mechanical motion motors are used, arranged on either the group or individual drive scheme. The table itself we print below:

PERCENTAGE LOSS OF THE ORIGINAL ENERGY IN COAL.

	Per Cent.
Through grate bars	1.00
By radiation from boiler	5.00
In chimney gases	22.00
By radiation from main steam pipes	1.56
By radiation from auxiliary steam pipes	.22
In auxiliary engines exhaust	1.40
By radiation from main engine	2.08
In main engine exhaust	57.31
In engine friction	.56
In electric generator	.36
In electric mains	.85
In transformers	.39
In motors	.73
	93.46

From this we see that of the total energy in the coal, which we can represent by 100, but 6.54 is delivered by the motors in the form of mechanical motion. While we do not know that these particular figures are absolutely accurate, still we have sufficient data on hand to show that they are not very far out. This loss which takes place is really appalling, and in spite of the efforts of the engine builders, it has been possible to modify it but very little. Evidently, then, the economical conversion of the energy of coal does not lie within the scope of the steam engine. In other lines, rapid advances are being made, and already the gas and gasoline engines have established records for themselves. In the engine using the cheapest grade of crude oil another advance has been made, but still this latter machine nas a thermal efficiency of but 30 to 35% of the energy

of the fuel. What the prime mover will be fifty or one hundred years hence, is impossible to say, but judging from the general trend of the matter at present, it appears likely that something in the line of an internal combustion engine will supersede the steam engine and boiler.

Use of Wattmeters. The question is often asked by the manager of a small power station, "Should I install recording wattmeters ?" To give an intelligent answer requires a very careful study of the local conditions, and in almost any event, the matter should be reduced to a dollars and cents basis. The meter idea is really the only scheme in connection with a steam driven plant, provided the plant is not too small. Where the plant is small, and all the consumers are small, then it is doubtful if any advantage will be gained by the installation of meters. But even if the plant be small, and there are one or two large users of power, it is probable that very satisfactory results will be obtained by putting these large consumers on a meter basis. When we get up to the large steam driven plants, then the almost universal practice is to put all consumers on meter rate. When the energy which drives the generator is water, then the matter assumes a different aspect. In the steam plant, each kilowatt-hour consumed means just so much coal burned. With the water power plant this is not the case, and up to a certain point, it makes no difference to the station how long each consumer burns his lamps. But in the case of either a small steam plant, or a water power plant, supplying current on a flat rate, the meter offers a means of reducing the total load on the generators, which is of great value. If your load gradually climbs up to and over your normal capacity, put in meters, and the load will forthwith drop. Make your rate so that this will not reduce your revenue. Another point is that if you are supplying free lamp renewals—and every plant should—the number of lamps burnt out on a metered service will be considerably lower than if no meters were used. Hence, considering that the customer pays a meter rental which just about compensates for the investment in these instruments, it is usually a satisfactory scheme to install them. But, as we mentioned before, good judgment must be used in dealing with the matter.

The Tantalum Lamp. The year 1905 has already earned for itself a place of distinction in electrical annals, for in it not only has the incandescent lamp, the invention of Mr. Thomas A. Edison, reached its quarter-century mark, but a new invention has been brought out which threatens to drive both the incandescent and arc lamp completely out of the lighting field. In the incandescent lamp we find a typical example of Mr. Edison's work—the invention, when placed upon the market, was as nearly perfect as the brains of that great man could make it, and when Mr. Edison declared that his investigation along any line was complete, then one felt reasonably sure that no improvements or modifications would be made for a long period of time. Such is the case with the incandescent, for the lamp of to-day has the same essential parts as the lamp of twenty-five years ago, and its general appearance has been altered but little. We do not mean to imply that no modifications have been made, for such is not the case, but merely that any changes which have taken place were of a detail nature, and have had practically no effect on the lamp. And now comes a revolution. In this issue we print a very able article by Dr. von Bolton and Dr. Feuerlein, covering their joint invention of the "tantalum lamp." The paper is complete in itself, and while it is not our intention to make lengthy comment in these columns upon the subject, we consider it advisable to call the attention of our readers to the points of greatest value in the matter which is thus placed before them. To the search for a proper material of which to make his filament, Mr. Edison devoted almost his entire time. Every substance which by some possible yet remote chance might have been of use was tried, and in the end pure carbon was adopted as the only satisfactory material. True, it had many bad points, but nevertheless, the fact that it could be raised to a high temperature without melting won for it acceptance. In the new lamp, the difference is entirely in the filament, which is made of tantalum, a metal which will stand hammering and drawing, can be raised to a very high temperature before melting, and resists the attacks of every chemical with the one exception of the all-powerful hydrofluoric acid. Another point in the favor of the new metal, and one which is worthy of being noted, is that it has a high specific resistance compared with other metals. This has been one of the drawbacks in connection with the use of any metallic substance--the resistances are so low that for use on our standard voltages, filaments of great length would have to be employed. As it is, with the tantalum lamp, the filament for a 110-volt circuit has a length of something over two feet. Were the metal a rare or costly one, the carbon would have nothing to fear, but as the matter now stands, tantalum exists in abundance in various parts of the world, and can be both easily and cheaply prepared for lamp use. Carbon has one very bad point, namely, a negative temperature coefficient. This is what causes such a quick burn-out on increased voltage. On the other hand, tantalum, like other metals, is positive, or in other words, the higher the temperature, the higher the resistance. In figure nine of the article will be found the curves showing the relation between the two substances, drawn on a basis of voltage and resistance. Messrs. Siemens & Halske have been the instigators of this research work, and the fact that their chemists have been engaged for over two years, gives some idea of the great perseverance which has been necessary to achieve success.

Ald. Cockburn and the committee of the Winnipeg City Coudcil which was appointed to look into the question of cheap electric power for the city are busy collecting data and hope to be able to present their report at an early date.

Mr. C. H. Rust, city engineer of Toronto, has recommended to the Board of Works that four centrifugal pumps of 5,000,000 gallons capacity each, be installed in the new addition to the main pumping station, two to be operated by electric motors and two by steam turbines.

The Southwestern Traction Company and the City Council of St. Thomas, Ont., have come to an agreement, the city accepting the company's offer for the use of St. Thomas Street Railway lines through the city. The company in return for a 50-year franchise, agree to pay tqe city $1,200 per year per mile for the first five years, $1,350 for the second, $1,500 for the third, $1,550 for the fourth, and $1,750 for the last five years making twenty-five years in all. They cellect no fares in the city, pay the cost of the power and pay one-half of the cost of maintaining the tracks.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

THE TANTALUM LAMP.*

By Doctor W. von Bolton and Dr. O. Feuerlein.

Part. I.—By Dr. W. von Bolton.

Whilst the carbon filament incadescent lamp remained for nearly two decades the sole representative of glow lamp manufacture, progress was being quietly made in this art. The firm of Messrs. Siemens & Halske has for many years been working at the solution of the problem of an economical incandescent lamp, and arrived, some time ago, at the fundamental principle that the visible part of the radiation of an incandescent body increases progressively with its temperature. This warrants the postulate that the most economical lamp will be that whose incandescent material will withstand the highest temperature.

Messrs. Siemens & Halske had arrived at this conclusion and charged me several years ago with the task of discovering a material which should have a melting point considerably above the temperature at which incandescent lighting becomes highly economical, so that filaments made of such a material would not melt or disintegrate at that temperature. Whilst our laboratory work, founded upon this idea, was going on, the first two advances in incandescent lighting were made public, one being the "Nernst" and the other the "Osmium" lamp.

There are certain metals the melting points of which are known to be considerably above 2,000°C., and the task resolved itself into finding one which, while fulfilling the above requirement, could be easily worked to form a filament, and not be very rare or difficult to procure. It was early observed that brown vanadium pentoxide, which, according to Berzelius does not conduct electricity, is, as a matter of fact, a conductor even when cold. This observation induced me to try whether venadic acid could not be electrolytically decomposed. In this I succeeded, but the melting point of the vanadium obtained proved too low for the purpose in view. Since the metals niobium and tantalum are members of the vanadium group, niobium having an atomic weight double that of vanadium, while the atomic weight of tantalum is double that of niobum, it was thought that one or both of these metals might prove to have the desired qualities. On experimenting with niobium on the lines adopted for vanadium, it appeared that this metal has a considerably higher melting point than that of vanadium, but not, however, sufficiently high; moreover, some of the niobium filaments which I made had a very strong tendency to break up when heated by the electric current.

Tantalum was tried next. I reduced potassium tantalo-fluoride in the manner prescribed by Berzelius and Rose and found that the finely divided tantalum so produced became fairly coherent on rolling, so that by this treatment metallic strips of it could be made. It was also attempted to work tantalum oxide into the shape of a filament by mixing it with paraffin and to reduce it directly into the form of a metallic thread. In these experiments there was observed for the first time a minute globule of molten tantalum, and this globule was of sufficient toughness to permit hammering and drawing into wire. Following out this observation, tantalum powder was melted in a vacuum, and then it was found that the highly-heated metal parted with the gases it contained. In this manner I produced my first filaments of pure metallic tantalum, which were, however, very small. When these had been used in lamps with promise of good results, an attempt was made to devise a definite process of purification. The potassium tantalo-fluoride was reduced to metallic powder; this powder contains a small proportion of oxide and of hydrogen which is absorbed during the reduction. When the powder was melted in a vacuum the oxide and absorbed gas disappeared, and a reguline metal remained; on carefully remelting this it became so pure that no appreciable impurities could be detected in it.

The chemical properties of this pure tantalum are very remarkable, and some of them are of such a nature as to lead me to suppose that nobody other than myself has ever had metallic tantalum in his hands. When cold, the material strongly resists chemical reagents; it is not attacked by boiling hydrochloric acid, aqua regia, nitric acid or sulphuric acid, and it is also indifferent to alkaline solutions; it is attacked solely by hydrofluoric acid. Following the behaviour of steel, when heated in the air it assumes a yellow tint at about 400° C., and the tint changes to dark blue when the tantalum is exposed for some time to 500°C., or for a shorter time to 600°C. Thin wires of the substance burn with low intensity and without any noticeable flame when ignited. It absorbs hydrogen as well as nitrogen with great avidity, even at a low red heat, and forms with them combinations of a metallic appearance, but rather brittle. It combines with carbon very easily, forming several carbides which, as far as they are at present known, are all of metallic appearance, but also very hard and brittle. The prodcut which Moissan thought to be tantalum was clearly a carbide of this nature or an alloy of a carbide with pure tantalum, for Moissan himself stated that his metal still contained ½ per cent. of carbon. Considering the high atomic weight of tantalum (183) it is obvious that a very small quantity of carbon suffices to carburize a relatively large quantity of tantalum. This view of the constitution of Moissan's product is confirmed by the properties he ascribed to the metal—namely, specific gravity 12.8, great hardness and brittleness. These are not properties of pure tantalum. When in the form of powder, still containing, as previously stated, oxide and hydrogen, the specific gravity of my material is about 14; when purified by fusion and drawn into wire it has a specific gravity of 16.8. It is somewhat darker than platinum, and has a hardness about equal to that of mild steel, but shows greater tensile strength than steel does. It is malleable, although the effect of hammering is relatively small, so that the operation must be rather long and severe to beat the metal into a sheet. It can be rolled, as well as drawn into very fine wire. Its tensile strength as a wire is remarkably high, and amounts to 95 kg. per square millimetre, while the corresponding figure for good steel is 70 kg. to 80 kg., according to Kohlrausch.

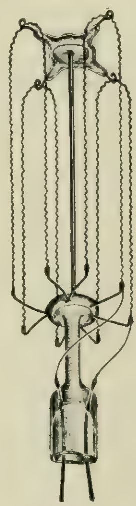


Fig. 1.—Lamp with Corrugated Filament.

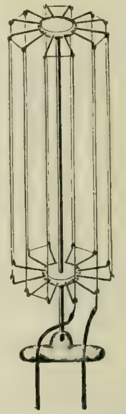


Fig. 2.—Early Type of Tantalum Lamp.

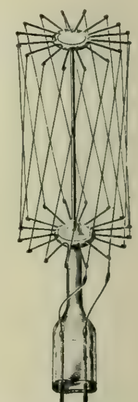


Fig. 3.—Tantalum Lamp with Filaments Fixed Obliquely.

The electrical resistance of the material at indoor temperature is 0.165 ohms for a length of 1 metre and a section of 1 sq. mm. (specific conductivity as compared with mercury 6.06). The temperature coefficient is positive, and has a value of 0.30 between 0°C. and 100°C. At the temperature assumed by the incandescent filament in the lamp at 1.5 watts per candle-power, the resistance rises to 0.830 ohms for a length of 1 metre and a

*Translation of a paper read before the Elektrotechnischer Verein of Berlin on January 17th, 1905.

section of 1 sq. mm. The coefficient of linear thermal expansion between 0°C. and 60°C. is 0.0000079, according to experiments made by the Imperial Normal-Aichungs Commission. Fusion is preceded by a gradual softening, which appears to extend over a range of temperature of several hundred degrees. The specific heat is 0.0365, so that the atomic heat is 6.64, which is in accord with the law established by Dulong and Petit.

PART II.—BY DR. O. FEUERLEIN.

The results of the work carried out in our chemical laboratory, as described by Dr. von Bolton in the first part of this paper,

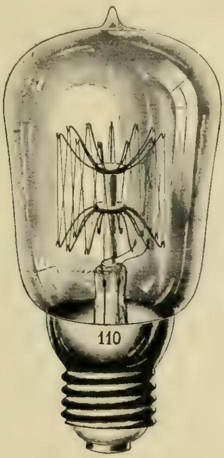


FIG. 4.—COMPLETE LAMP.

were, of course, of the utmost interest to our incandescent lamp manufacturing department. As soon as Dr. Bolton's experiments showed that the originally brittle tantalum could be made ductile enough to draw into wire by the usual methods, and that this wire could be bent and coiled like a thin steel wire, it became possible to test it thoroughly as to its usefulness for incandescent lamps. The first trials with wires of about 0.3 mm. diameter gave most promising results. They confirmed the fact that tantalum has a very high melting point, and that it is but slightly subject to disintegration in a vacuum, even when subjected to a heavy current.

The first tantalum lamp that proved moderately satisfactory in that it admitted of an exact measurement of the electric and photo-metric conditions and stood a burning test for some time, was completed just over two years ago—viz., on December 28, 1902. This lamp had a loop-shaped filament made of the first tantalum wire ever drawn. The diameter of the wire was 0.28 mm., its effective lighting length 54 mm. and its electrical resistance when cold 0.29 ohms. This corresponds to a specific resistance (1 metre length, 1 sq. mm. section) of 0.331. The photometric measurements made at efficiencies of 2, 1½ and 1 watt per Hefner candle-power showed potential differences of 4.9, 4.95 and 5.9 volts, currents of 5, 5.49 and 6.2 amperes, and illuminating values of 11, 18 and 37 Hefner candle-power respectively. On being burnt at 1 watt per candle-power the lamp had a life of 20 hours, during which it blackened considerably.

As chemical and mechanical manufacturing processes developed and the material became purer and the wires more uniform, the results obtained also improved. The lamps lasted longer and blackened less; at the same time the specific resistance decreased until it had dropped to the present figure of 0.165 for the pure metal. It is clear that the material used for the first lamps still contained a considerable quantity of impurities, probably niobium and carbides, which caused the great disintegration and the nearly double specific resistance. During these first trials we looked very carefully into the question as to what dimensions the filament of a tantalum lamp ought to have for ordinary voltages and illuminating values. From the dimensions of the filament used in the first lamp we calculated that, with this rather impure material, we should require a filament about 520 mm. long and 0.06 mm. diameter for a lamp for 110 volts, 32 Hefner candle-power and 1.5 watts per candle-power. These unusual figures increased when the specific resistance of the material had diminished to the present value of 0.165, at which for a 32 Hefner candle-power lamp, a filament of about 700mm. in length by 0.55 mm. in diameter was required; for a 25 Hefner candle-power lamp, a filament of about 700 mm. in length by 0.55 mm. in diameter was required. Thus, in order to construct a practical and useful lamp for standard voltages and illuminating values, we had to solve the problem of drawing the tantalum wire in sufficient length down to a diameter of 0.05 mm. to 0.06 mm.; this we succeeded in doing after long and laborious trials.

In July, 1903, we possessed the first tantalum lamp with a filament of about 0.05 mm. diameter. It had a loop-shaped filament 54 mm. long and it took 0.58 amperes at 9 volts and gave 3.5 Hefner candle-power at 1.5 watts per candle-power. On the basis of these figures a lamp having the same quality and diameter of wire and working at the same efficiency on a 110-volt circuit would have a filament 650 mm. long and would give 43 Hefner candle-power. The experiments thus far have proved that the task of producing lamps for 110 volts and a maximum of 25-32 Hefner candle-power was not an easy one in several respects. We had to solve the problem of suitably and reliably fixing a filament rather more than 2 ft. long within a glass globe which should not exceed to any great extent the dimensions of the usual incandescent lamps. The first and most obvious attempt was made, of course, by adhering to the loop shape and accommodating the required length of wire by connecting several such bows in series within the lamp. However, lamps made according to this plan with two to four tantalum loops gave results which were anything but satisfactory.

It appeared that, like all other metallic filaments which have hitherto been used for incandescent lamps, tantalum wire softens sensibly at the temperature attained when worked at 1.5 watts per candle-power. To use loop-shaped or spiral filaments similar to the carbon filaments of the common incandescent lamps, was, therefore, out of the question. There was no difficulty in suspending the loops, but in that case the lamps would have to be used exclusively in a vertical position, a limitation which we wished to avoid in all circumstances. Besides, such a construction would necessitate staying the loops firmly to prevent them from becoming entangled with each other during transport of the lamps. Nor did lamps made with loops of corrugated wire (Fig. 1), or of plain or corrugated metal ribbon, give satisfaction; for although the loops were certainly shortened in this way, there were other drawbacks which caused us to abandon the construction. It soon became apparent that the one road to

FIG. 5.—TANTALUM FILAMENT, BEFORE AND AFTER 1,000 HOURS' USE.

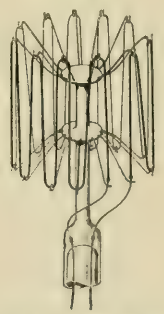


FIG. 6. FILAMENT FRAME OF A NEW LAMP.

success lay in the direction of dividing the filament into a number of short straight lengths supported at their ends by insulated holders. In this manner we succeeded at last, in September, 1903, in producing the first really serviceable lamps for about 110 volts. This lamp is illustrated in Fig. 2, and it will be seen that it contains two glass discs cast to a central wire holder; each disc carries laterally 12 arms having small hooks at their ends and insulated from each other. Through these 24 hooks the thin tantalum wire is drawn up and down between the two discs. This is believed to be the first metallic incandescent lamp for nearly 110 volts which, like the common carbon glow lamp, can burn in any position whatsoever. This lamp supplied about 30 Hefner candle-power on a 94-volt circuit at 1·5 watts per candle power. It lasted for 260 hours and lost during that time 9·5 per cent. of its illuminating power.

After this first practical success we redoubled our efforts to improve the lamp further. As far back as about the middle of

October, 1903, we succeeded in making the first 200-volt tantalum lamp, which was of a design similar to the lamp just described, but with 18 arms on each disc and with a greater distance between the two discs. I may add at once that it is of interest only as a curiosity, for it has served no practical purpose. The length of its filament was 1,350, mm. and the illuminating value about 60 Hefner candle-power. In the course of further development the form of the frame of wire filament for the 110-volt lamp went through different stages, the principle of subdivision being always followed. Among other constructions we tried some in which, instead of one long filament, a number of short pieces of wire were fixed on a supporting frame; these pieces, connected in series, made up the total length required. Fig. 3 represents a lamp thus constructed, the wire being fixed obliquely in 16 straight pieces between two insulated supporting stars. Such lamps offer the advantage that short pieces of filament can be used in the manufacture. But they are only reliable if the wire used in the same lamp are absolutely uniform in diameter and quality. In the end we arrived at the shape represented in Fig. 4, which is for 110 volts, 23 c.p. and 1·5 watts per Hefner candle-power. In this form, differing from most of the previous constructions, the central support consists of a short glass rod carrying two discs, into which the arms, bent upward and downward in the shape of an umbrella, are cast. The upper star has 11, the lower 12 arms, each upper arm being in a vertical plane midway between the vertical planes in which two adjacent lower arms lie. Between these 11 and 12 arms, which are bent into hooks at their ends, the entire length of the filament is drawn in a zig-zag fashion. Its extremities, held by two of the lower arms, are connected with the foot of the lamp by means of platinun strips.

Fig. 7. Appearance of Filament After Having Been in Use.

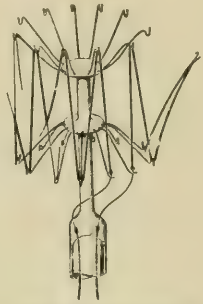


Fig. 8 Filament Frame, Showing Broken Filament.

The standard type for 110 volts 25 Hefner candle-power and 1.5 watts per candle-power has a filament 650 mm. long and 0.05 mm. in diameter. The weight of this filament is 0.022 grammes, so that about 45,000 lamps contain together 1 kg. of tantalum. The shape of the glass globe is adapted to the frame described above. Care has been taken to make it of a size not exceeding the usual maximum dimensions of common incandescent lamps of the same candle power (25 Hefner candle-power 110 volts). This shape offers a number of noticeable advantages. In the first instance it is very stable and will stand strong shocks without damage to the lamp. A considerable number of such lamps sent across the sea to test their ability to withstand the hardships of transport came back unhurt, although they had been packed just like common glow-lamps, and no special care in any respect had been taken in their handling. The lamp burns, of course, in any position, and can therefore be held in any kind of fitting. The light is rather white and agreeable, and its effect is particularly uniform if the lamp is provided with a ground-glass globe.

We shall now proceed to describe the electric and photometric properties of the lamp and its behaviour in actual use. Numerous trials for lengthy periods of time at 1 to 3 watts per candle-power have proved the vast superiority of the tantalum lamp over the carbon filament lamp under equal electric and photometric conditions. Expressing this fact in figures, we can state that the tantalum lamp consumes about 50 per cent. less current at the same voltage, with the same intensity of light and the same useful life; or that, at the same economy, its life is several times that of the carbon type. Moreover, at a[illegible]al efficiency of 1.5 volts per Hefner candle-power the tantalum lamp has an average life quite sufficient for all practical requirements, so that this rating has been standardized for the 110-volt lamp. Trials have also proved that the lamps have a life of several hundred hours at 1 watt per Hefner candle-power, but in that case they were very sensitive to variations of pressure, and often showed an early decrease of illuminating power. The useful life of the tantalum lamp—*i.e.*, the time within which it loses 20 per cent. of its initial illuminating power—averages between 400 and 600 hours at 1·5 watts per Hefner candle-power. Some specimens have proved to have a useful life of as much as 1,200 hours. The absolute life, in general, amounts to 800-1,000 hours under normal working conditions. Further we have to remark that the tantalum lamp blackens but little unless it has been strongly overheated during work in consequence of partial short-circuiting of the filament.

It is very interesting to observe the behaviour of the tantalum lamp during the whole course of its life. The first fact worthy of note is that, like some carbon lamps, the illuminating value increases at the beginning, generally after a few hours, by 15 to 20 per cent. In the same way the consumption of current rises by about 3 to 6 per cent., while the consumption of energy drops to 1·3 to 1·4 watts per candle-power. After that, the illuminating value gradually decreases, while a corresponding increase of the consumption of energy occurs. The average behaviour of the 25 c.p. lamp at 110 volts with reference to its various periods of life is shown in the following table:—

Life in hours.	Intensity of light in Hefner c.p.	Consumption of current in amperes.	Watts per Hefner c.p.
0	25–27	0·36–0·38	1·5–1·7
5	28–31	0·37–0·39	1·3–1·5
150	25–27	0·36–0·38	1·5–1·6
300	22 24	0·36–0·38	1·6–1·7
500	20–22	0·36–0·38	1·9–2·0
1,000	18–20	0·35–0.37	2·1–2·2

The initial increase of illuminating value and of current consumed is doubtless caused by a change in the structure of the tantalum wire, this change being accompanied by a reduction of resistance and, consequently, of the phenomena resulting therefrom. We may say at once that after a certain amount of use the filament presents a radical change in appearance when viewed with the naked eye. While the fresh filament has a perfectly smooth and cylindrical surface, it acquires a peculiarly glistening aspect as it grows old, so that a lamp having served for some time can be readily distinguished from a new lamp. When looked at under the microscope, the filament that has

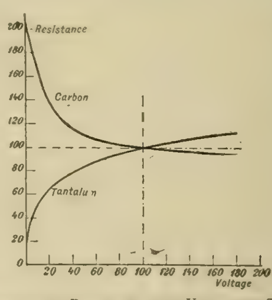


Fig. 9.—Variation of Resistance with Voltage of Tantalum as Compared with Carbon.

burned for a length of time shows a clear tendency towards contraction and formation of drops or beads. Fig. 5 is an illustration of a piece of filament in its fresh state and of the same piece after 1,000 hours of service, the specimen in each case being magnified 100 times. This gradual shortening of the filament can also be observed in the lamps themselves, and offers a further indication of the age of a lamp.

Fig. 6 represents the filament frame of a new lamp. It will be noticed that the tantalum wire is led up and down and hangs loose on the supporting frame in easy wide arches, without sharp bends. But after being used for some time the aspect of the lamp is quite different. As shown in Fig. 7, the wire has contracted, the wide arches have disappeared and sharp-pointed angles have taken their place.

The behaviour of these lamps is most peculiar when the filament has burnt through. While with all other incandescent

lamps the burning through of the filament is tantamount to the economical death of the lamp, it may happen with tantalum lamps that they burn through several times without being rendered useless; on the contrary, each burning through is followed by an increase, often considerable, of the illuminating power. This peculiar result is due to the fact that in many cases a broken wire comes in contact with its neighbour, so that the circuit is again established. A part of the filament is thus cut out of the circuit, and the lamp consequently burns more intensely, and sometimes even too intensely, in which case, of course, only a short span of life is left to it. Yet we have had more than one lamp under observation, the filament of which broke for a first time after a short period of service and then broke repeatedly, but notwithstanding this the lamp lived more than 1,000 hours. We have often succeeded in rendering a lamp with a broken filament serviceable again by tapping it to bring the broken piece into contact with its neighbour. Fig. 8 represents the frame of a lamp in which the filament was burnt through in three places, and yet continued to do service. For the sake of clearness, the back spans of the filament have been omitted in the drawing, while the front spans which were carrying the current are drawn in specially heavy lines.

It must further be mentioned that after serving for some time, say 200 to 300 hours, the tantalum filament loses a great deal of its mechanical resistance; while, as has been stated by Dr. V. Bolton, tantalum wire, when new, has a greater tensile strength than steel; it becomes brittle, and will break easily in the course of its life as a filament. It is therefore advisable when lamps have served for some time not to remove them from their old fittings and put them into new ones, as that might easily cause the filament to break. New lamps are not very sensitive to strong shocks, even while burning, but when this alteration in the filament has occurred it is well to preserve them from shocks.

The behaviour of the tantalum lamp under a very great increase of voltage is of special interest to the incandescent lamp maker. As was to be expected, the trials made in this respect have also shown the superiority of this lamp over the carbon lamp. It has been ascertained that tantalum lamps for 110 volts, 25 Hefner candle-power and 1·5 watts per candle-power only burn through at 260 to 300 volts if the pressure is increased slowly and gradually, while with carbon lamps designed to work under the same conditions nothing like that figure can be obtained. The superiority of the tantalum lamp over the carbon lamp with regard to blackening of the glass globe can also be proved in a few hours by means of comparative burning tests at about 30 per cent. overload.

Another advantage of the tantalum lamp over the carbon lamp is that the resistance of tantalum, like that of all other metals, strongly increases with the rise of temperature, while carbon is known to diminish in resistance when it is hot. In Fig. 9 the variation of the resistance of tantalum and of carbon as a function of the voltage is graphically represented, the pressure being assumed as 100 volts and the resistance at 100 arbitrary units when the efficiency is 1·5 watts per Hefner candle-power, so that for each per cent. of variation of voltage the respective percentage of variation of resistance is shown. It will be seen in the first instance that the resistance of the tantalum increases to more than five times its original value from the cold state to 1·5 watts per Hefner candle-power, while the resistance of the carbon decreases to about one-half of its initial value. It will further be noticed that even afterwards the resistance of tantalum goes on rising, while the resistance of carbon keeps dropping. Therefore the increase or decrease of pressure causes the strength of current, and with it the illuminating value, to rise or fall at a quicker rate in the carbon lamp than in the tantalum lamp, and, consequently, the latter is less sensitive to variations of pressure than the former.

Having thus related the whole history of the development of the tantalum lamp, and fully entered into a critical comparison between it and the carbon filament lamp, we need scarcely add that we do not intend, of course, to be satisfied with what we have already obtained. For the time being, however, and until a larger building has been erected for the production of tantalum, our firm has resolved to keep to the type for which there is an immediate practical demand. That is the lamp for 100 to 120 volts, which supplies 25 Hefner candle-power at 110 volts, or will have a higher or lower illuminating value if worked at correspondingly higher or lower voltages. In conclusion I would recapitulate the properties which we claim as peculiar characteristics of our invention as follows :—

1. The tantalum lamp has a filament made of a metallic conductor and burns at once on being connected without any previous heating.

2. The light-giving wire is prepared by melting in a vacuum and drawing; it is tough even in the cold state, and can therefore be coiled and fixed in the lamp when cold.

3. A relatively great length of wire can be placed in a simple manner within a bulb of ordinary dimensions.

4. Tantalum ore exists in considerable quantities and can be easily procured.

5. Similar principles of treatment can be adhibited to other metals of a very high melting point.

TRADE NOTES.

The Montreal Light, Heat and Power Company have just given a contract to the Sunbeam Lamp Company, of Toronto, for their supply of lamps for the next three years.

The Babcock & Wilcox Company, of Montreal, have secured the contract to supply two h. p. water tube boilers for the waterworks pumping station at Winnipeg, Man. Their tender was $14,750.

The Rosebank Lumber Company have ordered two 100 horse power return tubular boilers to be fitted with Dutch ovens for their saw mill at Douglastown, N.B., from the Robb Engineering Company, of Amherst, N. S.

The Borden & Selleck Co., 48 East Lake Street, Chicago, make a specialty of manufacturing and installing conveying and elevating machinery for all purposes. Those of our readers who may be interested are referred to their announcement in this paper and are invited to open correspondence with them.

The Manitoba Iron Works, Limited, of Winnipeg, have under construction in their boiler shop a tubular boiler 7 feet in diameter, 18 feet long, shell 9-16ths of an inch, with head ⅝ of an inch, eight rows of rivets and 106 4 inch tubes. The boiler is guaranteed for a working pressure of 140 pounds and will be installed in the new sash and door factory of the Rat Portage Lumber Company.

We understand that the Syracuse Smelting Works, of Montreal, are receiving some very large orders for their "Manganese" anti-friction metal. This metal is adapted for all classes of electrical machinery, and although it has not been on the market very long, it is having a large sale. The company are sending on application miniature bars of this metal, which can be used as a paper weight.

Mr. John S. MacLean, B. A., who for thirteen years has been a member of the editorial staff of the Toronto Globe, was recently appointed manager of the publicity department of Allis-Chalmers-Bullock, Limited, Montreal. Mr. MacLean is well qualified to discharge his new duties and his wide knowledge of newspaper work should make him a valuable addition to the large staff of Allis-Chalmers-Bullock.

The Syracuse Smelting Works, of Montreal, are sole agents for the Montreal Copper Company, who are always in the market for old copper wire, which they use for eliminating sulphur from copper ores. The Montreal Copper Company is the only concern in Canada that is producing refined ingot copper and they have lately received some very large orders for export, including one for 200,000 pounds of refined ingot copper for shipment to Germany.

Mr. G. C. Mooring, who has been with the Methodist Book & Publishing House for the past sisteen years as engineer and machinist, is leaving their services, having bought out the machinery plant and stock in trade, and also the boiler compound business of the late Wm. Sutton. Mr. Mooring will conduct a modern machine shop, making a specialty of printing and bookbindingmachinery, at 82 Adelaide St. West. He has our best wishes for success.

There has been considerable renewal of activity in mining operations in central Ontario recently and many of the companies have made large increases in their plants. The Kingston Felspar Mining Company at Bedford purchased from Allis-Chalmers-Bullock, Limited, Montreal, a hoisting plant, including a 30 double cylinder Lidgerwood engine; James Richardson & Sons, zinc miners, Mountain Grove, purchased an Ingersoll-Sergeant air compressing plant, and the Madoc Mining Company at Tweed purchased a complete mining plant, consisting of a horizontal return tubular boiler, Ingersoll Sergeant air compressor, Lidgerwood hoisting engine, etc., from Allis-Chalmers-Bullock, Limited, Montreal.

ELECTRICAL WORK IN WINNIPEG.

Western Office of the CANADIAN ELECTRICAL NEWS,
720-721 Union Bank Building, WINNIPEG, March 6th, 1905.

The various branches of electrical industry in Winnipeg have during the past year been kept busy endeavoring to keep pace with the marvelous growth of the city, and it is only owing to the energy of the men in charge, backed by the financial interests behind them, that the various services have been extended to meet the demands made upon them.

The Winnipeg Electric Railway Company has, of course, felt the pressure the most—constant additions have been made to their plant and rolling stock as well as to the gas works operated by them. Recently the company have greatly increased in all departments, and they are now figuring on more extensions for the coming summer. The company have lately been amalgamated with the Winnipeg General Power Company, who have for the past two years been developing an extensive water power on the Winnipeg River some 65 miles distant from the city, and which is nearing completion. It is fully expected that this current will reach the city early during the coming fall. The company at present operate a single phase system for lighting, primaries 60 cycle, 2080 volts, and secondary wiring 110 and 220 volts. Commercial power circuits are all 500 volt D.C. The company's management have not so far encouraged the use of alternating motors, but apparently this policy may be changed in the near future, as some three phase apparatus has lately been installed. Mr. Wilford Phillips is general superintendent of the company's entire plant.

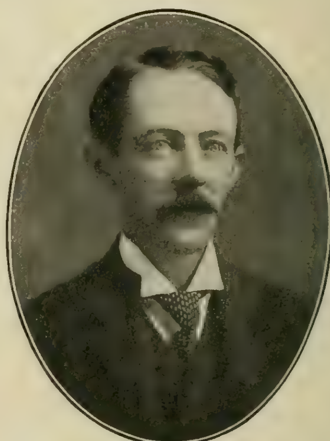
The Bell Telephone Company are just about completing a large addition to their building which will double their capacity. The company have a very complete central energy system and furnish an excellent service to about 3500 subscribers. They are making extensive additions to their underground system and are also erecting a large amount of aerial cable. The long distance system is also being pushed throughout the province and is proving very popular.

The Canadian Pacific Railway Company's telegraph department have also had a busy year. They have made large wire extensions throughout the West and have done some underground work in the city in connection with the company's new hotel and depot.

The G. N. W. Telegraph Company have been extending their service to the south, especially in their leased line system to St Paul, Minneapolis and Chicago.

The city electrical department report having had a busy year. The municipal lighting system has been extended considerably by the addition of over one hundred street arc lamps. The plant is operating 362 street arcs, 196 of which are D. C. series open 9.6 amp. and 166 series enclosed alternating 7.5 amp. Constant current transformers of the "tub" type are used on the alternating circuits, four 50 light transformers being in use. The generators consist of three Western Electric Company 100 light D.C arc machines; one 350 k.w. three phase alternating Canadian General R.F. generator, and one 60 k.w. S.K.C. two phase generator. Primary current is distributed for the lighting of about 2,000 incandescent lamps in the various civic buildings at a pressure of 2,200 volts. The city is also installing a 400 h.p. induction motor at their water works building for driving a centrifugal pump. The city has lately installed a number of series incandescent street lamps of 50 c.p. These are used on streets having long blocks without street intersections. They are connected in series with the arcs on the alternating circuits and have proven very satisfactory.

The fire alarm system now operates 116 street alarm boxes and a number of "auxiliary" boxes of the Gamewell type, which is the only auxiliary box that is approved for connecting to city circuits. The Ogilvie mills, the C.P.R. shops and buildings, and the general hospital are now equipped throughout with this valuable service. The city looks after the operation of these boxes, makes regular tests and reports and incidentally derives a revenue from the same. E.M. gongs are installed in eleven fire stations and other buildings and there are three circuits of "tapper gongs" in residences of members of the fire department. The system is operated almost entirely "manually," as there are operators on duty at all times. A branch exchange telephone service with trunk lines to central is installed in the fire alarm office so that intercommunication between the various stations can be had without going



MR. F. A. CAMBRIDGE,
City Electrician, Winnipeg, Man.

through central and all the stations can be simultaneously called in event of a telephone alarm coming in. Storage batteries are used for current supply to the various lines; the latest type of chloride accumulator type "P.T." being installed. There are five box circuits and four main gong circuits, the latter being normally all connected in series at the fire alarm office, but are so arranged that any loop can be instantly cut out in event of trouble.

The electrical department had an active year in the inspection of interior wiring. Two men are now constantly engaged on this work. No current can be used on any installation without a permit of the department. Last year 1905 permits for installation of wiring were issued covering 28,316 incandescent lamps, also motors aggregating 1808 h.p. and a number of generators for private plants, in addition to 85 interior arc lamps.

The electrical contractors of the city report having had a satisfactory year, but owing to keen competition prices have been cut down to a ridiculously low figure. Several efforts have been made to form a contractors' association, but so far unsuccessfully.

MR. F. A. CAMBRIDGE.

Mr. F. A. Cambridge, City Electrician of Winnipeg, has been a resident of the city since July, 1883, and has been engaged in electrical work for the past fourteen years, having been identified with the North-West Electric Company of that city since its inception in 1890. Mr. Cambridge resigned his position in that company in 1898 to accept the position of city electrician, an office just then created by the City Council, his duties at that time being the supervision of wiring, both exterior and interior, and inspection of street lighting. In July, 1899, he was placed in charge of outside construction of the city's municipal lighting system then being initiated. In 1902 he was instructed by the Council to install a new fire alarm system for the city—the city at that time only owning the boxes and the wiring being the property of the Bell Telephone Company, who were operating the system for the city. On the completion of the system he was placed in charge of its operation. In the fall of 1902 he was placed in charge of the operation of the city's municipal lighting plant, succeeding Mr. James Stuart, late Water and Light Commissioner. He is a past vice-president of the International Association of Municipal Electricians.

TORONTO BRANCH A. I. E. E.

The Toronto Branch of the American Institute of Electrical Engineers held two very interesting meetings during the past month. The sixteenth meeting was held at the School of Practical Science on February 24th, when Professor Rosebrugh introduced for discussion Mr. B. G. Lamme's paper on "Synchronous Motors for the Regulation of Power Factor and Line Pressure," which created a lively discussion.

On Thursday evening, March 9th, a joint meeting of the A.I.E.E. and the Engineers' Club was held at the club rooms of the latter, 96 King Street West. Mr. H. A. Moore, E.E., reviewed Mr. Mershon's paper on "The Maximum Distance to which Power can be Economically Transmitted." Before dealing directly with the paper he referred briefly to the progress of electric power transmission. With the advent of the induction motor the demand for transmitted power was increased enormously, and to-day long distance power transmission systems were being considered to supply whole districts. He believed the success of very long distance electric power transmission was closely associated with the question of whether the trunk railways in future will use electricity or steam as their motive power.

Mr. Mershon concludes that the distance which electric power can be economically transmitted depends upon economic conditions rather than engineering difficulties. Mr. Moore pointed out that in voltages, say above 100,000, many obstacles were encountered in securing proper insulation, reduction of leakage losses, etc., and the limit of distance was soon approached. It was generally admitted that for long distances large blocks of power must be transmitted at high voltages, and that the cost of developing power decided in large measure the distance which it could be economically transmitted. He knew of one power which had been developed for $50 per h.p., while many others had cost from $150 to $200 per h.p. Naturally the cheaper development would permit of the power being profitably transmitted the greater distance. The public, however, did not appreciate the great cost of delivering power after it had left the power house. Mr. Mershon, in his calculations, had assumed exceptionally favorable conditions, the cost of power at the power house being fixed at the very low figure of $10.90 per kilowatt per annum.

An interesting analysis of the curve sheets was made by Mr. Moore to emphasize the limitations under different conditions. Taking the first cost at $10.90 per h. p., and selling the power at $34, and transmitting 25,000 kilowatts at a pressure of 70,000 volts for a distance of 100 miles, the net profit on investment would be 13 per cent. If the same amount of power were carried 200 miles, the economical voltage would be raised to 85,000 volts, but the net profit would be only 7 per cent. If increased still further to 300 miles, the voltage could be raised to 88,000 and the profit would be reduced to 3 per cent. In the last instance the line loss would be 13 per cent. It would appear, therefore, that the limit of distance for a transmission of 25,000 kilowatts is 100 miles.

Taking an output of 50,000 k. w. and transmitting 100 miles at 90,000 volts, a profit of 20 per cent. is shown. For 200 miles the voltage could be increased to 100,000, and the profit would be 13 per cent., while for 300 miles, at a pressure of 105,000 volts, the profit was reduced to 9 per cent. Thus, according to Mr. Mershon's calculations, the limit for 50,000 k. w. was 200 miles.

Mr. Moore said that the above estimates, although based on more favorable conditions than would be likely to be experienced in practice, were nevertheless of great interest in Southwestern Ontario, where coal costs $1.50 per ton more than in the Eastern States. The question of the transmission of Niagara power vitally affected the development of this section of the Dominion.

In the discussion which followed Mr. Moore's remarks, the advisability of constructing storage reservoirs to maintain a constant flow of water was suggested, and it was shown that this had been done in several instances. The expediency of doing so, however, depended largely upon the cost of providing such reservoirs. Mr. Moore said that he believed the small water powers would be coupled up with the larger developments, and would be used as auxiliaries to help out during periods of low water in certain districts.

Replying to a question, it was stated that Mr. Mershon had concluded that the limit of distance of transmission would, for some time at least, be in the neighborhood of 550 miles.

Reference was made to the vast number of water powers to be found throughout almost the entire Dominion excepting Manitoba and the Territories and to the great possibilities for the engineer in the development of these powers.

On behalf of the Engineers' Club and the Toronto Branch of the A. I. E. E., a hearty vote of thanks was tendered to Mr. Moore for his presentation of the subject.

Mr. C. H. Rust, City Engineer of Toronto, Ont., is preparing data as to the cost of installing a civic electric light plant, as the contract with the Toronto Electric Light Company expires within a few months.

TELEGRAPH and TELEPHONE

CENTRAL EXCHANGE OF THE BELL TELEPHONE COMPANY, TORONTO.

With the new addition which has recently been completed, the Central Exchange of the Bell Telephone Company on Temperance street, Toronto, is, in point of arrangement and equipment, one of the most complete in America. The enlargement has permitted the company to rearrange the different offices and departments so as to secure the best possible results, which had not been possible for some time previous owing to the rapid growth of the telephone business rendering the accommodation inadequate.

The Exchange as it now stands is a three-storey pressed brick fire-proof structure having a frontage of 95 feet and a depth of 85 feet, and is sufficiently large to provide for the prospective growth of the company's business for some years to come. The entrance is at the centre of the building, and on the ground floor to the left is the business office, with the manager's office adjoining. This floor is used entirely for offices and long distance accommodation.

The second storey of the building is devoted to the power plant and distributing departments, while the upper storey is used exclusively for operating purposes.

The entire telephone service of Toronto is now operated on the common battery or central energy system, whereby the whole of the current necessary to operate the telephones is generated at the central office. Although this system is doubtless understood by most of our readers, a brief explanation of the method of operating may be instructive to some.

Miniature incandescent lamps, controlled by relays, take the place ofthe self-restoring annunciators formerly used. These lamps are easily seen, take up but little room, and may be placed immediately below the jack with which they are associated, thus facilitating the operator's work considerably. To signal the central office, a subscriber merely removes the telephone from its supporting hood,when a lamp connected with his line at the central office lights, drawing attention to that line ; on the operator inserting the plug of one of a pair of connecting cords in the jack of the calling line, the lamp is extinguished. The operator after enquiring for the number wanted, completes the connection with the second cord. Associated with these cords are supervisory lamp signals, also controlled by the switch hook at the subscriber's station. If the cord is connected to a line and the telephone of that line is on the switch hook, the lamp associated with the cord lights up, if the telephone is off the hook the lamp remains dark; consequently the operator has a positive signal in front of her as to the condition of the line, being able to tell at a glance whether a subscriber has answered a call and whether a conversation is finished and the lines should be disconnected, or whether an error has been made and the subscriber requires further recognition.

If a subscriber, after using the telephone, leaves the receiver off the hook, he of course disconnects himself with Central. To draw the subscriber's attention to this, the wire chief is notified and inserts a plug which connects that line with what is called a "howler." On hearing this noise the subscriber's attention is drawn to his 'phone and he finds that it is off the hook. When a line is out of order a circuit is put on which notifies the operator of the trouble, but as soon as the line is in working order again the trouble test ceases to work and the operator knows that the line is ready for use.

When, during the night, the operators have an increased number of lines to look after and all the lights may not be clearly visible, an efficient service is provided by means of a night bell, which is rung when a call comes in and attracts the operator's notice to the board. Resistance lamps divide the current equally all along the switchboard so that one operator cannot take the power away from another in using one section of the board frequently. The bells on the telephone—in fact the whole signal system, which includes the "busy test" and the "howler," are operated by a special machine.

The great advantage of the central energy system is that a great deal of work is taken from the ear and given to the eye of the operator, thus permitting more efficient work.

The switchboard of the Toronto Exchange has a capacity for 9600 subscribers' lines.

MONTREAL OPERATING ROOM OF THE C. P. R. TELEGRAPHS.

The operating room of the C.P.R. Telegraphs in Montreal is one of the most modern establishments of the kind in America. There are worked from this office three duplex wires to Winnipeg, one duplex to Vancouver and various duplex and quadruplex circuits to Chicago, Toronto, New York, St. John, Halifax, Canso, Quebec and Ottawa. All cablegrams over the Pacific Cable between Australia, New Zealand and Great Britain pass through this office. In fact, telegrams circulate through it to or from all parts of the world. Current for working the wires and instruments is supplied by twelve motor dynamos, giving various strengths of current according to the length of the wires. Each machine works for eight hours and rests four ; there being reserve machines for this purpose. These machines are of the Lundell type, manufactured by the Sprague Electric Company, New York. They were installed about four years ago and we are told that they have cost nothing for repairs during that time, notwithstanding that they are operated eighteen hours every day in the year.

From conversation with Mr. James Kent, manager of C.P.R. Telegraphs, it was learned that each wire before entering the switch is protected by two different fuses and a lightning arrester so as to prevent heavy foreign currents or lightning from injuring the apparatus or building.

All wires running from the operating tables pass through a distributing rack before reaching the switch. All transpositions of wires are made in this distributing rack, diagrams being kept which enable the chiefs in charge to promptly trace any wire in the office.

The switchboards are of the latest pattern, being specially designed so that no metal comes in contact with any part of the wood-work. They are equipped with what is known as the " Skirrow " extension cord.

The messages are carried from the receiving room to the operating room in pneumatic tubes ; a bell ring-

ing in the receiving room indicates that the carrier has reached the operating room. In the delivery department a small motor drives a pair of rollers for the purpose of taking impression copies of all telegrams received.

A new call box system has just been established. It is the most up-to-date system in Canada, and although the installation was only commenced about three months ago, over 1,000 boxes are now in operation throughout the city.

ANNUAL MEETING OF THE BELL TELEPHONE COMPANY.

The statement issued at the twenty-fifth annual meeting of the Bell Telephone Company, held in Montreal last month, shows that the company now operate 475 exchanges and 789 agencies, with 66,160 sets of instruments earning revenue. During the year 1904, 8,988 new subscribers were gained, and 1,242 miles of wire added to the long distance system, which now comprises 32,211 miles of wire on 7,866 miles of poles.

The total receipts for the year 1904 amounted to $2,838,000; the expenses including bond interest, etc., totalled $2,231,000. The net revenue for 1904 was $701,000. Of this sum the dividends took $588,000, leaving the sum of $113,000, which was carried to reserve, accident and contingent account.

The president, Mr. C. F. Sise, stated that in 1885 the long distance mileage amounted to 2,000 miles; today it is 32,000 miles; ten years ago there were 69,000,000 exchange connections during the twelve months, now there are 228,000,000 during the same period. Ten years ago the subscribers throughout Canada numbered 29,000; to-day there are 66,000 instuments earning rental. He stated that the company would move into their new building in Montreal on May 1.

The President said that much criticism had been caused by the introduction of the slot telephone. These machines had been introduced for the reason that certain subscribers had not lived up to their contract,which does not permit a use of the telephone by the general public. He remarked that within three days of the time the slot machine was introduced into saloons, cigar stores, etc., different firms had come and subscribed, indicating that they had for years been conducting their business over their neighbors' phones.

The board of directors and the officers were all re-elected, as follows:—C.F. Sise, president; Hon. Robert Mackay, vice-president; E. P. Fish, Robert Archer, Wm. R. Driver, Hugh Paton, Charles Cassils, Thos. Sherwin.

SHORT-CIRCUITS.

A telephone company is being organized, with a capital of $25,000, to construct a telephone system in the Temiskaming district.

The Board of Trade of Orillia, Ont., has appointed a special committee to gather information with a view to the installation of a municipal telephone system in that town.

Steps are being taken looking to the construction of a rural telephone system in Waterloo County, Ont. A special committee has been appointed to report upon the cost.

The Nanaimo Telephone Company, Nanaimo, B. C., has been absorbed by the British ColumbiaT elephone Company, and it is understood that extensive improvements will be made by the new owners.

The Bell Telephone Company will this spring commence the erection of a new telephone exchange on Clarence street, Kingston, Ont. It will be a two-storey building, with grey pressed brick front, and will cost about $30,000.

The International Telephone Company has been registered in British Colombia as an extra-provincial company, with local head office in Vancouver. The company has a capital of $50,000, their general headquarters being at Bellingham, Wash.

The C. P. R. Telegraph Company have made arrangements to erect one thousand miles of copper wire and eight hundred miles of ordinary wire during the coming season. Most of the lines will be built in Western Canada, including a fourth line from Winnipeg to Vancouver, B. C.

Incorporation has been granted to the Markham & Pickering Telephone Company, Limited, with a capital of $40,000 and head office at Whitevale, Ont. The provisional directors are Messrs. A. Hoover and D. R. Beaton, of the township of Pickering, and A. C. Reesor, of the township of Markham.

The Scarboro Telephone Company, Limited, has been incorporated at Toronto, with a capital of $40,000. Permission is given to carry on the business of a telephone company in the counties of York and Ontario. The directors include Dr. T. A. Young, of Markham, and William Mulock, jr., of Toronto.

A veteran telegrapher died in Montreal on February 16th, in the person of Mr. James Poustie. Deceased came to Canada from Scotland and entered the employ of the Montreal Telegraph Company, steadily advancing from clerk to the position of superintendent of construction. He was widely known all over the Dominion.

The Richibucto-Rexton Telephone Company, Limited, has been incorporated by the New Brunswick Government, to acquire the telephone systems of the Kent Electric Company, Limited, and the Kent Telephone Lines Company, Limited, and to construct telephone systems in different parts of that province. The capital stock is $20,000, and William J. O'Leary, electrical engineer, of Montreal, is one of the promoters.

PERSONAL.

Mr. George L. Oill has been appointed manager of the electric light and gas plants controlled by the corporation of St. Thomas, Ont.

Mr. Wright, superintendent of the St. Johns Electric Light Company, St. Johns, Que., has resigned, and Mr. S. E. Fletcher, for a number of years electrician of the company, has been appointed superintendent.

Mr. A. M. Townsend, formerly of Halifax, N.S., but for some years connected with electric railways in the United States, has been appointed general superintendent of the Cape Breton Electric Company, of Sydney, N.S.

Dr. Jack has tendered his resignation as Dean of the Engineering Faculty of the University of New Brunswick at Fredericton, and has accepted the position of city engineer for a city in Virginia, at a salary of $2,200 per annum.

The many Canadian friends of Mr. P. G. Gossler, late of the Montreal Light, Heat & Power Company, Montreal, will be pleased to learn that he has been elected one of the Vice-Presidents of J. G. White & Company, the well known engineering firm of New York.

Mr. J. M. Buntzen, general manager of the British Columbia Electric Railway Company, left recently on a flying trip to England to consult with the directors of the company regarding the electrification of the Lulu Island branch of the C. P. R., which was recently acquired by the company.

Mr. G. B. McBurney, widely and favorably known as travelling representative in Eastern Ontario for the Canadian General Electric Company, has been appointed manager of the Winnipeg office of that company and has already assumed his new duties. Mr. McBurney carries with him the best wishes of a large circle of friends in the East.

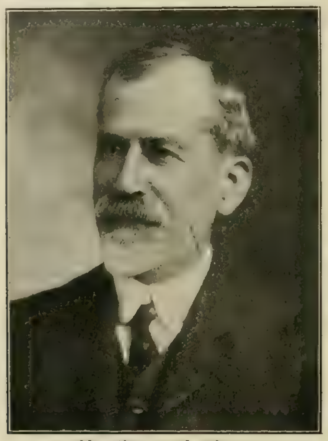
The first important change to be made in the staff of the Mexican Light and Power Company has occurred through the resignation of Mr. Hugh Cooper, resident engineer at Mexico. Mr. Cooper has had charge of the construction works, and owing to his resignation, Mr. F. S. Pearson, vice-president and consulting engineer, has gone to Mexico to reside till all the works are completed. Mr. Cooper built the plant of the Sao Paulo Tramway, Light and Power Company.

Mr. Thomas J. Mullin, superintendent of construction for Allis-Chalmers-Bullock, Limited, Montreal, was recently married in Cincinnatti. Prior to leaving Montreal he was tendered a farewell dinner at the Engineers' Club by the staff of the head office. The chair was occupied by Mr. Alfred Collyer. During the evening Mr. Mullin was presented with a handsome set of carvers and was also the recipient of a number of congratulatory telegrams from different parts of the country.

MR. GEORGE L. OILL.

Mr. George L. Oill, who has been appointed by the city of St. Thomas, Ont., to continue the management of the electric light and gas plants which the corporation expects to acquire about May 15th at a valuation of over $200,000, was born in the village of Jamestown, South Yarmouth, County of Elgin, March 22nd, 1846. With his father, he removed to the historic Quaker village of Sparta, where he received a good common school education. After arriving at the age of manhood he located in St. Thomas, the county town of his native county, where he has resided continuously up to the present.

While pursuing commercial industries, Mr. Oill has devoted his energy to the advancement of the interests of the city, having been a representative on the Council Board for a number of years and filling the position



Mr. George L. Oill,
Manager Electric Light and Gas Plants, St. Thomas, Ont.

of Chief Magistrate for two years. During his term as Mayor a monetary transaction by which the city profited to a large extent was arranged, namely, the sale of the city's bonds in the London and Port Stanley Railway for an amount of $40,000, which bonds as an asset were considered almost valueless. He was largely instrumental in securing the adoption of the frontage system of providing for permanent street improvements, the outcome of which has been the construction of substantial and beautiful streets.

Ten years ago Mr. Oill was offered the position which he has since filled as manager of the gas and electric light plants. These plants have been rebuilt and enlarged on three different occasions under Mr. Oill's supervision; larger and more efficient engines and dynamos have been installed in the electric department, and increased manufacturing capacity in the gas department was completed last year. The combined plants are now capable of taking care of the light and power business of the city much more satisfactorily than in previous years.

While Mr. Oill was not an advocate of municipal ownership of lighting plants, he believes there is no reason why the business should not prosper and flourish under the city's control so long as favoritism and "log rolling" are not indulged in.

The Fairville Electric Light Company, Limited, are seeking incorporation to light the village of Fairville, N.B. James Ready is one of the promoters.

MONTREAL

Branch office of Canadian Electrical News,
Imperial Building.

March 8th, 1905.

Electric door bells out of order have been a chronic complaint in Montreal; a new annoyance has cropped up in the shape of factory telephones. Poor wire, cheap intercommunicating instruments, and bad installation are to blame. It is noteworthy that wiremen do not take the care they should in installing circuits operated by power from batteries, whereas in some respects more care even should be taken than for electric light wiring.

A case is now with the court in Quebec where the Quebec Railway, Light & Power Company are being sued by an insurance company for damages resulting to a house by fire through electric origin. It is claimed that the transformer broke down and that the primary current was carried into the residence, causing the damage. The experts for the Lighting Company were Mr. R. S. Kelsch, E. E., and Mr. J. M. Robertson, of the Montreal Light, Heat & Power Company. Those for the insurance company were Mr. W. J. Plews and Mr. Leonard, all of Montreal. The verdict has at date of writing not been rendered.

It has been decided that Montreal will be Edison sockets and 110 volts after May 1st, 1905. The company are to be congratulated on this decision, as it simplifies stock for the supply dealer. Although the bulk of standard supplies are now to our credit "made in Canada," yet novelties are often purchased the other side of the line and which invariably are put on the market first to suit their standard over there, which is now the same in Montreal. There is also, we believe, some slight royalty on the use of porcelain T.H. bases which all manufacturers have now adopted and which will be eliminated by the use of Edison.

The Montreal City Council, in debating the removal of snow from the streets, have made a statement to the effect that the Montreal Street Railway Company will not take the contract for the work unless granted a long extension of franchise. The company, however, are business men and have never had a chance to tender for it on a monetary basis, and even were they paid a good round sum for such service it could not possibly come more expensive than the present method of "tea chests upon sleighs," the average load of which is about ten shovelfuls.

It would be interesting to know what it has cost the city to collect the $5.00 tax on "each establishment using motors"; also what the Manufacturers' Association are doing about its re-collection during 1905?

A company with a modern plant and 84 feet head of water have lately commenced operations at the Chasm at Chateauguay N.Y. As this is but 7 or 8 miles from our border towns, they are offering to transmit energy to some of them.

A rumor has reached us that the genial Fred Thomson contemplates setting sail on the sea of matrimony about the middle of June next, and immediately thereafter will embark with his bride on a pleasure trip to England. His many friends wish him *bon voyage*.

The main Bell Telephone exchange are showing that "Centra Energy" is on the wing. Their men are out now installing condensers.

The main exchange of the Merchants Telephone Company, situated at 80 St. Lawrence street, was completely demolished in the fire there lately. The damage was $18,000; covered by insurance. The fire started in Tuckett's cigar factory under the exchange. A building on Vitre street has been secured and will be fitted out to replace the St. Lawrence street office as quickly as possible. They have two other small branch exchanges in other sections of the city which helped out considerably. The whole concern is said to be controlled by New York capitalists.

Wiring contractors galore still remain in Montreal, some being "of a sort." True, some die out in the winter, but a fresh crop sprout with the spring. They number somewhat like 93 and those of financial responsibility might readily be counted on the fingers of one hand. The reason for this fungus growth is not hard to find. Let any reputable contractor discharge a wireman, say, owing to work being scarce; he visits a supply dealer, confides to him that he will probably start "on his own hook." "Good," says Mr. Dealer, "you can run credit here"—this in many cases without knowing whether the wireman has a cent to his name. Yes, even to four figures has been offered. The dealer then wonders why he does not have more support from the five wise virgins.

As to the supply dealers themselves, make a round of them, get a 20 cent price from one, the next will better it by a cent, the next by another, and so on till their absolute cost is reached. As to trade protection, it exists, but a telescope is required to find it; why, as high a protection as one-quarter of one per cent. is thought good in not a few lines.

A telephone message to a supply house lately to "send up a wagon load of electricity to thaw out my water pipe" was referred to the Montreal Light, Heat & Power Company, whose outfit has done good work in that line.

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. APRIL, 1905 No. 4.

ELECTRIC POWER DEVELOPMENT IN BRITISH COLUMBIA.

One of the most important water-power developments for the generation and transmission of electric energy is now approaching completion at Coquitlam Lake, eighteen miles north-east of Vancouver, B.C. This enterprise was inaugurated in August, 1902, by the Vancouver Power Company, of Vancouver. The general manager of this company is Mr. J. M. Buntzen, to whom is due the credit of financing the undertaking. Mr. William Meredith is consulting engineer, the engineers in charge of the work being Messrs. E. B. Hermon and H. M. Burwell.

Coquitlam Lake, the main source of water supply, has an area of 2,300 acres and an altitude of 440 feet above sea level. The watershed to this lake is about 100 square miles. Trout Lake, the secondary source of supply, has an area of 500 acres and an altitude of 400 feet above sea level. A range of mountains 3,000 to 4,000 feet high separates these two lakes a distance of two and one-half miles.

Through this range of mountains a tunnel nine feet square has been driven, the contractors for this part of the work being Messrs. Ironside, Rannie & Campbell, of Vancouver. With the exception of the tunnel and the clearing of some of the land, all the work was done by day labor.

Work on the tunnel was proceeded with from both ends, the material to be cut through being granite. The total length of the tunnel is 12,775 feet or about two and a half miles. At the Coquitlam portal it was necessary to start the working tunnel above the lake level. This was run down on a grade of 6 per cent. until the finish tunnel grade was reached. The finish tunnel was afterwards constructed directly beneath this working tunnel, and steel gates placed in it. These gates are operated from the working tunnel above. Tram lines were built into the tunnel at both ends and the debris hauled out by electric motors. Ventilation was accomplished by means of a 12 inch galvanized iron pipe connected with two fans which served to extract the gases caused by the explosives. Fresh air was to a large extent supplied by exhaust from the air drills. In this manner exceptionally good air was maintained. Retiring stations for the workmen were provided 1,000 feet apart. The average rate of progress on this tunnel was fifteen feet per day.

VANCOUVER POWER COMPANY DAM AT LAKE BEAUTIFUL.

Half a mile below the outlet of Trout Lake a concrete dam was constructed spanning a ravine. This dam is 361 feet long on the crest, and has a maximum height of 54 feet. By its construction an extra area of sixty acres has been flooded. Another dam of rock-filled timber construction has been placed at the outlet of Coquitlam Lake for the purpose of raising the level of the lake by 10 feet and creating storage.

Provision has been made for ten pipe lines to extend

from this dam a distance of 1,800 feet to the power house. As yet only three of these pipe lines have been built and put in operation. The upper 800 feet of these pipes is constructed of wooden stave pipe 54 inches in diameter and the lower 1,000 feet of steel ranging from 48 to 42 inches diameter.

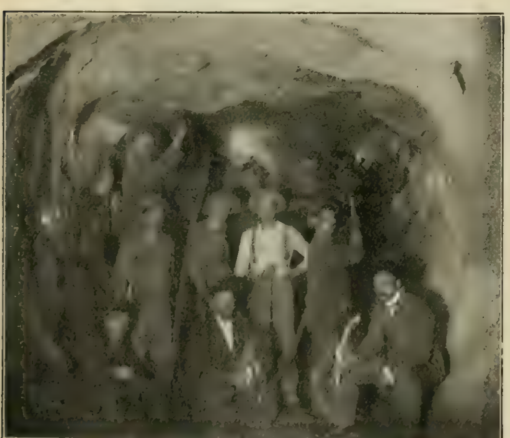
The power house, a stone structure on concrete foundation, 156 × 34 feet in size, is located at sea level, and is believed to be the only one in the world so placed. It has a capacity of four units of 3,000 h.p.

Vancouver Power Company—Portal, Trout Lake Tunnel.

each, of which there are at present three in operation.

The installation consists of Westinghouse generators and Pelton water wheels. Each unit consists of a generator set in the center of shaft with Pelton wheel on each end, the whole revolving on two bearings. This is said to be the initial use of this method, and the result has been most satisfactory.

The transformers are housed in a separate building, 42 × 68 feet in size, located about 100 feet from the power house and constructed entirely of concrete. From this point a double pole line extends along the



Vancouver Power Company—Heading Trout Lake, 6,000 Feet.

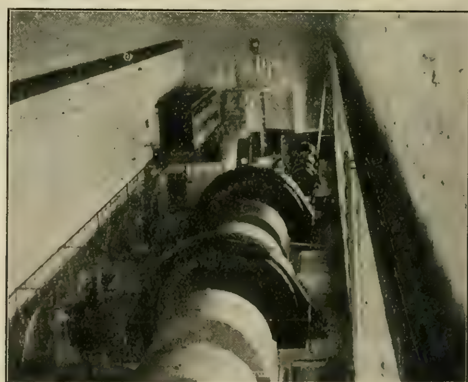
shores of Trout Lake, crossing Burrard Inlet at Barnet, the span at this point being 2,750 feet. On the southerly side the cables are supported on two steel towers each 140 feet high. There are twelve steel insulated cables, the current being transmitted at a pressure of 20,000 volts.

The tower anchors are supported on concrete piers. The anchorage is accomplished by separate anchorage towers. The strain for each cable comes on 28 insulators. These insulators are set in pairs. A cast iron

Vancouver Power Company—Power House and Pipe Line, Lake Beautiful.

cap is fitted over each insulator, and a steel yoke fits over each pair, being fastened on to the cable by means of a clip. Thus the strain comes first on the clips and is then transmitted to the yokes. The yokes are adjustable for the purpose of equalizing the strain in each pair of insulators.

These works have been designed to give at ultimate highest capacity 30,000 h.p. The power developed will be used for lighting and power in the cities of Vancouver, New Westminster and neighboring municipalities, including the operation of electric railways in Vancouver, between Vancouver and New Westmin-



Vancouver Power Company—Interior of Power House.

ster and the proposed new line between Vancouver and Steveston, a distance of seventeen miles.

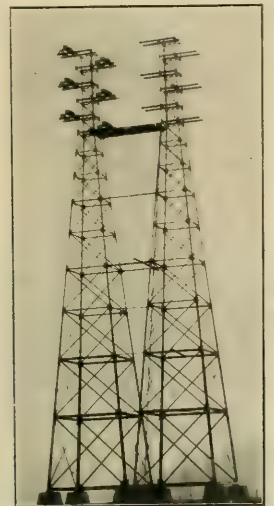
The Fessenden Wireless Telegraph Company of Canada has recently been incorporated.

The Stark Telephone Light & Power Company, of Toronto, held their annual meeting last month, when the former directors were re-elected. The president informed the shareholders that he had the authority of the directors to state that a dividend at the rats of 7 per cent. per annum would be declared in July on the preference stock of the company. The company intend erecting a new building at Toronto Junction.

CANADIAN ELECTRICAL ASSOCIATION.

Satisfactory progress is being made by the various committees appointed to complete arrangements for the annual convention in Montreal. June 21st, 22nd and 23rd are the dates selected.

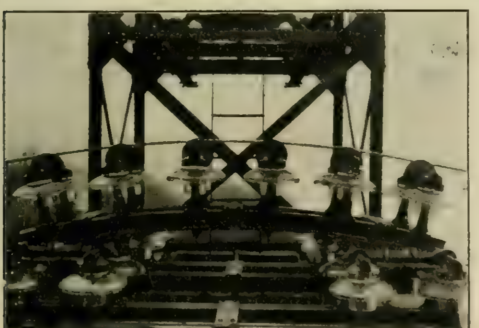
Electrically and in every other respect Montreal is an



VANCOUVER POWER COMPANY—ONE OF THE STEEL TOWERS.

interesting city and, entirely apart from the interesting features of the convention, will well repay a visit.

A special effort is being made in preparing the programme to supply papers and subjects for discussion which should interest and benefit owners and operators of central stations and it will pay these to attend the meeting. A few dollars spent in meeting the people in one's own line of business and comparing notes and



VANCOUVER POWER COMPANY—TOP OF STEEL TOWER, SHOWING UNIQUE CONSTRUCTION OF CABLES.

experiences with them, usually proves a good investment, and as it is pretty certain to be so in this case, every wide-awake central station man should resolve to be there.

A composite telephone system between Sherbrooke and Farnham, Que., has just been installed by the C. P. R.

Mr. Alex. Smith, who recently retired from the position of superintendent of the mechanical electrical department of the Toronto Railway, was presented by the members of that department with a purse of money and a very beautiful gold locket, with his monogram engrossed thereon. The presentation was made by Mr. W. Macrae.

AN 8,000 H. P. MOTOR-GENERATOR SET.

The great frequency changer at the Montreal sub-station of the Shawinigan Water and Power Company, of which we show a view on the following page, has peculiar claims to the attention of electrical engineers. It includes the largest motor ever constructed and the largest alternating current generator now in operation. The set completed the contract of Allis-Chalmers-Bullock, Limited, Montreal, for the installation of the machinery at the sub-station necessary to convert the alternating current transmitted from Shawinigan Falls 86 miles away, to meet the requirements of the city.

The current is generated at Shawinigan Falls at 2,200 volts, 30 cycles, and transmitted to Montreal over aluminum cables, the voltage being stepped up to 50,000. As the contract of the Shawinigan Company called for delivery of power in Montreal at 60 cycles, and as it was found more convenient to transmit it at 30 cycles, it was decided to change the frequency at Montreal by synchronous motor-generator sets. For this purpose the Shawinigan Company have erected a large terminal station at Montreal in which at present are installed five 1,200-h.p. frequency changers and one 8,000-h.p. frequency changer, built for the contractors by the Bullock Electric Manufacturing Company, Cincinnati. In addition there are two 800 k.w. rotary converters in connection with two 900 k.w. three phase transformers to supply direct current to the Montreal Street Railway, built by Allis-Chalmers-Bullock, Limited, Montreal.

The 8,000-h.p. synchronous motor-generator set consists of a 5,750-k.w. alternating-current generator, an 8,000-h.p. synchronous motor and a direct-connected induction motor for starting purposes, all mounted on the same base. The motor is capable of developing a maximum starting torque equivalent to 2,500 h.p. The total weight of this set is almost 500,000 pounds.

The armature yoke of the generator is made of cast iron, cast in halves, which are held in proper alignment by dowel pins and square splines, and securely bolted together. This casting is so cored as to allow the egress of an abundance of air for ventilation and still it is strong enough to form a rigid support for the armature. The yoke is built up of steel laminations .014 in. thick, which are punched simultaneously with the slots from specially annealed sheet steel. They are annealed after the punching in specially constructed furnaces and then japanned to prevent eddy currents. As a further prevention against the formation of eddy currents, tissue paper is placed between the punchings at intervals of ⅛ in. Throughout the steel core brass castings are spaced at frequent intervals, which provide for ample ventilation. The coils are firmly supported by a wooden block bolted to the stator yoke shields on each side, thus rigidly holding the coils in case of heavy short-circuits. They are held in place in the slots by seasoned hardwood wedges. The total weight of the stator is 80,708 pounds.

The construction of the rotor is one of extreme strength. Upon the spider, which is of cast steel, are built up the steel laminations 1/16 in. thick. At suitable intervals spacing blocks 2 in. wide are inserted for the purpose of thorough ventilation. Dove-tailed slots are stamped in the rim of these punchings for the reception of the poles, which are held in place by

wedge-shaped steel keys. The poles, of which there are twenty-four, are also built up of soft sheet steel, held together by phosphor-bronze end plates, securely riveted. Each pole weighs 1,130 pounds and the complete rotor weighs 78,455 pounds.

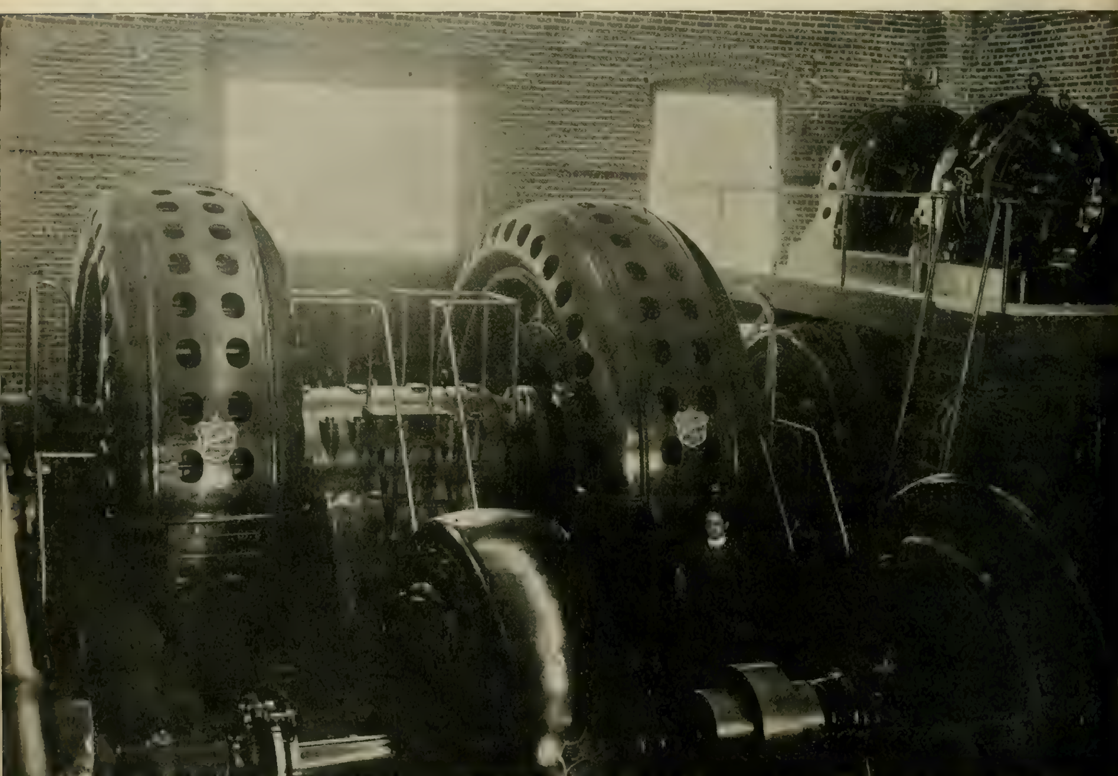
The mechanical construction of the synchronous motor is quite similar to that of the generator, there being, however, only twelve poles, each weighing 2,200 pounds. The complete stator weighs 93,250 pounds, and the rotor complete weighs 80,595 pounds.

These machines are rigidly connected together by a coupling forged with two flanges, the flanges at either end of the shaft being securely bolted to the spiders of each of the above machines. The rotor of the induction motor is mounted on the extension of the synchronous motor shaft. The weight of the metal required for babbitting the three bushings was over 10,000 pounds.

The base is cast into four sections, viz., the two end sections for the main motor and generator, the middle section for the third bearing and a section for the induction motor. These separate parts are held in proper alignment by square keys and securely held together by shrink rings and bolts. The total weight of the base is 56,080 pounds.

This set was tested under full load conditions in the shops of the Bullock Company by the method originated by Mr. B. A. Behrend, chief engineer of the company.

In testing the generator, having twenty-four poles, the machine was connected so that twelve poles were in opposition to the other twelve poles. Half of these coils would then be acting as a generator and the other half a motor. The armature current would tend to magnetize the poles of the motor half and demagnetize the poles of the generator half, which would subject the machine to violent vibrations. In order to obtain magnetic balance each half is excited differently by placing a rheostat in series with each section and regulating the current. The C^2R loss is also accurately obtained in this manner, as full load current is made to circulate through the armature coils and also full load current is carried by half the number of poles. This unique frequency changer now in successful operation will make valuable additions to the existing data on alternating current machinery. The exciter for thi set is shown in the view elevated on a platform about 12 feet high, owing to the lack of space in the building. It consists of a 200 kw., 120 volt, direct current Bullock generator, which supplies direct current to the field of the frequency changer, directly connected to a 300 h.p. induction motor of 400 revolutions, the latter built in the shops of Allis-Chalmers-Bullock, Limited, at Montreal.



8,000 H. P. Frequency Changer Installed in Sub-Station of Shawinigan Water and Power Company, Montreal.

The People's Telegraph & Telephone Company, Limited, has recently been incorporated, with head office in the village of Maynooth, Ont., the object being to carry on a telegraph and telephone business within the county of Hastings. The promoters include Mr. W. J. Sergeant, banker, of Bancroft, and Mr. W. J. Fitzgerald, lumberman, of Maynooth.

CARE AND OPERATION OF TRANSFORMERS.

By M. A. Sammett.

The extensive use of alternating currents for ligthing purposes and the growing appreciation of their advantages as compared with direct current in the industrial application as a motive power, have made the alternating current transformer a very widely used apparatus. Every central station of any magnitude operates static transformers, whether the distribution in the business section of the city be by direct or alternating current. In a small city with a scattered load the alternating current appeals to the central station manager, in view of its better adaptability for reaching the customers at a smaller expense. In larger cities, where the business section consumes a considerable portion of the station's output by direct current distribution, the generation, transforming and transmitting of the power to the point of distribution are done frequently by alternating current, which is converted to direct current in a substation situated conveniently in that locality.

In view of the wide use of the static transforming apparatus, some suggestions as to the proper care and operation of both service and station transformers may be of interest. The good operation of transformers is often an inherent characteristic of the transformer proper, and depends altogether on the design of the apparatus. Given a good transformer, then if properly installed, connected to a load within the requirements of the guarantee and with proper precautions taken to protect the machine from lightning and static disturbances on the line and possible severe overloads, the transformer will remain in service and require no attention except for a systematic inspection, which should be kept up by every central station. This inspection should consist in an examination of the leads, transformer temperature and of the lightning arresters on the line. The benefit derived by both the station management and the public will more than repay the

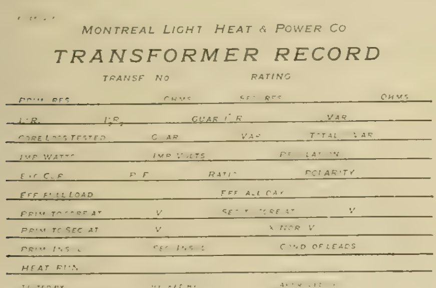


Fig. 1—Front of Transformer Record Card.

extra expense of instituting such an inspection. A defective lightning arrester will cause the burn out of a transformer. Transformer leads, exposed for a long period to the weather, are likely to become bare of insulation and come in contact with the case, grounding the high voltage on the low tension winding, and find its way into dwellings. Such possibilities of fatality that may cost customers their lives and the operating company expense for damages will be done away with under a rigid system of inspection. Safety of the customer should always be the watchword of those entrusted to some extent with the lives of the citizens and on this account no pains should be spared to fulfill the obligations to the public.

Whenever changes are made on the line and transformers shifted from one locality to another, it is advisable that they should always be brought into the testing room, and no transformers should be allowed to be taken out unless they have an O K tag, indicating that the transformers had the required test and are in good condition for service. The testing department should keep a full record of all transformers. Herewith will be found a copy of transformer record card made

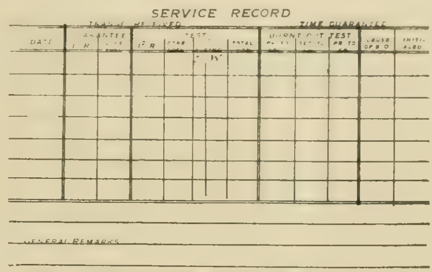


Fig. 2—Back of Transformer Record Card.

up by the writer and used in the testing department of the Montreal Light, Heat and Power Company. If the transformer had a full test, the only additional tests necessary when transformers are returned to the station, are those of reliability of the insulation between the primary and secondary coils, as well as the insulation between the primary winding and core, and secondary winding and core. In addition to this, it is advisable to test for the exciting current and core loss at the operating voltage and normal frequency. This latter test will enable one to keep track of the changes in the magnetic properties of the core.

Next to the safety of the transformer, the question of its efficiency should be looked after. In some of the old type transformers the iron ages to such an extent as to make their further use detrimental to the economy of the station. The risk of a break down under such conditions of high temperatures is great, and out of consideration of safety and efficient operation such transformers should be removed. Some very interesting cases of abnormally high iron losses in transformers came under the writer's observation, and the following table contains a few of the figures:

Capacity.	Exciting current in % of full load current.
½ K. W.	24.8%
1 K. W.	28.2%
1 K. W.	19.5%
1 K. W.	16.5
1½ K. W.	12.5
2½ K. W.	33.3
2½ K. W.	23.6%

This table hardly requires any comment. The figures do not call for any elaboration.

Taking up the consideration of the various types of transformers, we will subdivide them into several groups, classifying them as follows:

1. Dry, natural draught.
2. Oil insulated.
3. Oil insulated, water cooled.
4. Air blast.

Starting with the first mentioned--natural draught, dry transformer--it may be safely said that this type of apparatus is obsolete. It belongs to the pioneer class and has proved in service to lack some very important features. Of these the failure during lightning storms and static disturbances on the line, due to switching, are among the most serious objections to that type. Another consideration which is against the dry transformer is that it is of necessity a bulkier transformer for the same efficiency and consequently a more expensive apparatus, or for the same

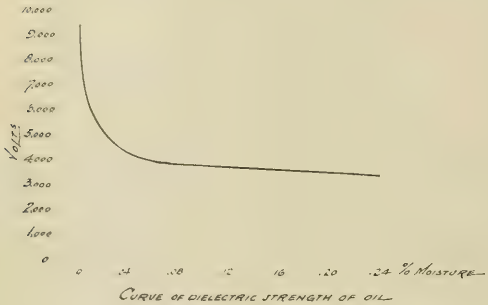


Fig. 3.

amount of material, and for same size, it will be a less efficient apparatus.

2. The transformer which is becoming the universal type is that of the oil insulated class. The oil serves a double purpose. In the first place, it acts as a cooling medium, carrying the heat away from the interior to the transformer tank, which dissipates the heat into the surrounding atmosphere, and in the second place takes care of static brush discharges, filling in the puncture made by these discharges and thus healing the defects caused by them. In view of the importance of oil as an insulating medium in transformers, it is essential that the oil should be of the best quality obtainable, and while every transformer manufacturer claims the oil he uses is the best on the market, the customer will do well by subjecting the oil to a dielectric test. From tests made on various samples of oil used by the numerous companies, all oils have about the same dielectric strength, but due to unforeseen conditions in shipment, the barrels being exposed to rain or snow, a certain amount of water and moisture may find their way into the barrel and greatly weaken the insulating properties of the oil. The testing department should try every barrel of oil used and if the disruptive voltage comes below a certain fixed value, the oil should be rejected. The di-electric test alone is sufficient, as it will always detect defective oil, whether the defect be due to moisture, water, acid or other foreign matter.

An adjustable spark gap immersed in a glass vessel and set for 1/8″ should withstand a pressure of 20,000 volts, and no oil should be allowed in transformers which will not stand the minimum disruptive voltage of 15,000 volts. The effect of moisture on the insulating properties of oil is shown in the curve above. Mr. C. E. Skinner, of the Westinghouse Electric & Manufacturing Company, has found, as shown in that curve, that as little as .06°/。 of moisture will reduce the disruptive strength from 10,000 volts to 4,000 volts.

Whenever dry or oil transformers are kept indoors, some means should be provided for a free passage of air through the room. While it is essential under such circumstances to have the place fire-proof, an insufficiency of free air to carry away the heat given off by the transformer case will raise the transformer temperature considerably.

(3) As the oil insulated type of transformers is manufactured only in sizes up to 150 K. W., the larger units are provided with cooling devices having water circulated in pipes immersed in the oil. By this artificial means the size of the apparatus is kept down, as efficient means are provided for carrying away the heat dissipated in the iron and copper. This latter type of apparatus is becoming the standard type, especially in high voltage work.

(4) Whenever the voltages are not exceeding that of 25,000 volts, many consulting engineers prefer to specify air blast transformers, as in this case it is not essential to keep them in separate fire-proof compartments. Whenever the air blast type can be used, the lay out and wiring of the station is greatly simplified. In the last two types the successful operation of the apparatus depends on artificial cooling, and it is well to have duplicate means provided for the artificial cooling. So in the case of the oil-insulated water cooled transformers, means must be supplied by which a duplicate source of water circulation could be accessible. Using air blast transformers, two sets of motor blower units should be installed, both of them at the same end of the air chamber, so as to allow their operation at the same time whenever emergency may require. As a further safety in the case of oil-insulated transformers, special piping should be made by which, when the transformer is on fire, water could be admitted into the transformer at the bottom on the case, forcing the oil out through a pipe on the top of the case and into the sewer. Oil transformers should always be enclosed in separate fire-proof compartments, and means be provided by building an external case around it, by which the transformer

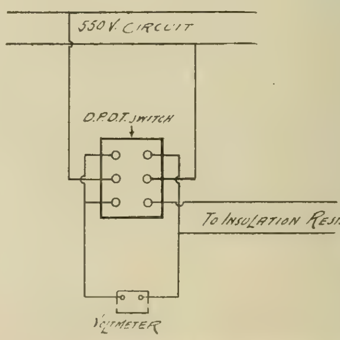


Fig. 4. Connections for Insulation Test.

could be immersed entirely in water, should it be threatened by an external fire as that of the building.

Another important feature in using water cooled transformers is that of having a guage which would be helpful in discovering any water that may settle down in the bottom of the transformer tank, through a defective water coil.

Automatic devices should be installed in the instance of the water cooled and air blast transformers which would enable the station operator to take immediate steps and disconnect the transformer with a leaky water

pipe, or the spreading of fire from one air blast transformer to another. Signal bells can be wired so as to warn the station man of the approaching danger of the water settling in the transformer. Two leads placed close enough in the bottom of the glass guage when connected with a column of water will complete the circuit and ring an alarm bell. So with the air blast transformers, a gate should be placed underneath every unit and in case of fire the blast should be immediately shut off without interfering with the safe operation of any other unit in the same station.

Occasional trouble in water cooled transformers is attributed to leaving water in the pipes when the transformers are taken out of service. It is very important whenever the apparatus is disconnected that the water is completely removed, as otherwise in cold weather the water freezing is likely to burst the piping, and when connected to the water mains will become filled with water and cause the destruction of the winding.

If the presence of water is discovered in oil, the water and oil should be completely removed and the coils baked on a short circuit long enough to restore the insulation resistance to a safe point. New oil should be used preferably, but if this cannot be had conveniently without considerable delay, the water should be drained off and then the oil heated until all the moisture is driven out. In this connection it may be well to dwell more at length as to the method of drying out on a short circuit. The baking by external heat should be avoided and resorted to only when it is impossible to improvise means for electrical baking by the heat of the coils proper.

In transformers of larger capacity where the cooling is affected by either a blast of air or water circulation, the voltage necessary to force full load current through the coils will amount to approximately two per cent. of the full primary voltage. In smaller sizes the impedance voltage would vary from two to three and three and one-half per cent. of the full voltage. In the case of a 10,000 volt transformer, 200 volts applied to the high tension terminals will cause the flow of the normal current in both primary and secondary winding when the secondary winding is short circuited. It will be found, however, that the full load current will heat up the transformer too much, and if the temperature characteristics of the transformer are not known, lower voltages should be applied and a fraction of full load current used on a preliminary trial. The coils should be carefully watched and thermometer temperatures should not be allowed to pass beyond 90° C. The drying out should be continued until the insulation resistance has reached its maximum. The insulation resistance may be measured by the aid of a 600 D. C. voltmeter (see Fig. 4). Connect the transformer coils to the underground side of the direct current circuit in series with the voltmeter on one side of a D.P.D.T. switch, and right across the circuit on the other side the meter only. With constant impressed potential take two readings :

1st—Line voltoge—voltmeter only.

2nd—Voltage as read on meter used with insulation resistance in series.

Then using the following notation:

V = Line voltage.

v = Voltage reading when insulation is in series with meter.

Rm = Resistance of voltmeter.

Ri = Resistance of insulation.

The insulation resistance will be expressed as follows:

$$R\,i = \frac{R\,m\,(V - v)}{v}$$

It will be observed that the insulation resistance will be gradually increasing as the drying goes on, and will finally reach a point which will be the maximum resistance at the temperature at which the transformer is maintained, which should be kept uniform. Whenever transformers operate in parallel, it is absolutely necessary to verify that they will divide the load equally, if of the same capacity, or proportionally if of different capacity. Too great reliance in a manufacturer's claim as to what certain apparatus will do may lead to disastrous results, and a complete destruction of the station. Before transformers are multiplied their impedance should be determined and under no circumstances should transformers be used which will not divide the load within a few per cent. of the capacity of each transformer. Beside making sure of the impedance of transformers, they should be checked for ratio and polarity. The ratio of all transformers used in multiple should be correct within one-half per cent., as otherwise it will give rise to excessive circulating currents. The polarity of all transformers should be the same, as otherwise the transformer of reverse polarity will be short circuited on the rest of the transformer bank. Every station operating air blast transformers should have compressed air accessible for the purpose of blowing out the dust from the transformers, which should be done every other Sunday (the day of light load) if possible. The accumulation of dust is likely to lead to grounds and result in the burning out of the apparatus. Considerable precaution must be taken in using compressed air, as no moisture should be allowed to pass with the first rush of air from the tank. The air should always be permitted to discharge for some time before it is turned on the transformer. To minimize the amount of dust settling in the transformer, protecting screens in the air chamber will be of great benefit. For the safety of the operator all transformers kept within the station should have their cases well grounded, and for the safety of customers all secondary coils of service transformers should be grounded at the neutral point.

In conclusion it may be well to say that in three phase distribution it is good practice to use delta connected transformers in units of three for each group. The continuity of service is an important consideration, and whenever possible this arrangement should be adhered to. Should one of the units burn out, two-thirds of the load can be carried on the other two transformers, or the two transformers overloaded may carry the entire load for a short period until the defective transformer is replaced.

Besides securing continuity of operation, the delta connection is very desirable on account of not having the objectionable feature of the Y connections or T connections used in phase transformation. With the latter combinations an open circuit on one of the transformer secondaries under conditions of load is likely to be productive of highly destructive voltages resultant from the combined effect of the inductance of the open circuited transformer and the capacity of the line.

Mr. John Galt, C. E., of Toronto, has prepared plans for water-works, sewerage, and electric light systems to be constructed by the municipality of Indian Head, N.W.T. It is proposed to submit a by-law to the ratepayers to raise $140,000 for the purpose.

A NEW GENERATOR.

By William Asahel Johnson, Toronto, Canada, (Inventor.)

The alternating current generator of the revolving field type herein described is considered by the writer and admitted by parties who have investigated and noticed the machine in operation to be a decided advance in dynamo design. The claim is made that this generator is superior in regulating qualities and in efficiency, and operates at a far lower temperature than generators of the old type. The type of revolving field adopted by the largest manufacturers in America and Europe is simply the multipolar field common to all commutating or direct current machines. Such construction has been the habit for the last fifteen years; during at least this period there have been brought out no designs having novelty or showing a new theory or principle of magnetic design. Aside from Tesla's motor, one is practically justified in saying there have been no new distinctive types of electric machines placed on the market during an even greater period, as the patents issued have covered mere details of design such as various devices for regulation, designs for laminating the frame or motor, etc., but no material or basic invention.

Fig. No. 1 gives an end view of this generator and shows also a short circuited winding which in this instance was used to give the machine self-starting ability when intended for use as a synchronous motor. That is, under light load the machine can be directly thrown on the line as an induction motor and when up to the speed the field can be excited and thereafter operate as a synchronous motor. This auxiliary winding would also be of use where two or more generators are run by separate engines and intended to be operated in parallel, as they would keep in synchronism better at any reasonable change in speed of the engine. This digression from the main question, i. e., the new field, readily admits of this special short-circuited winding and without very material increase in expense of construction. The writer desires to state, however, that such extra winding is not essential to his machine when used as a generator, but simply adds extra qualities when used as either a generator or synchronous motor, and such extra qualities are not so readily to be obtained in the other usual design mentioned in the first part of this article.

The new rotating field is shown in Fig. 2. The field may be mounted on horizontal or vertical shaft to suit the driving power. The radical and novel change in design will be readily seen by examining Fig. 3, which shows the old or usual type or revolving field. It can be readily seen that inasmuch as the function of the rotor (the field or primary) is first, to provide the magnetic field, and second, to vary the position of the magnetic flux flowing from the primary as relating to the armature (the secondary),—that the field electric (the copper winding) and magnetic (the iron) circuits are in a better balanced position as regards the inductive action taking place between field and armature than in any alternator yet designed. The magnet system of any generator controls the generation of the current, in fact, the magnet is the prime and essential feature of a generator, and yet the armature has been commonly looked upon as the chief point, and so common has been this habit that the armature has hitherto chiefly received the best thought and efforts of electrical people; but there is no getting over the fact, the magnet system in an electric machine is, and always will be, utterly indispensable, and the greater the perfection of its design and the stronger and more constant the flow of magnetic flux from its polar faces, the more efficient the generator and the more constant the electro-motive force generated, and all this depends upon the definite alignment of the magnetic poles by the establishment of an unchangeable neutral line that is a line of zero potential. Absolute regulation and a cool and efficient machine are the ends aimed at. The construction herein described achieves these desirable objects.

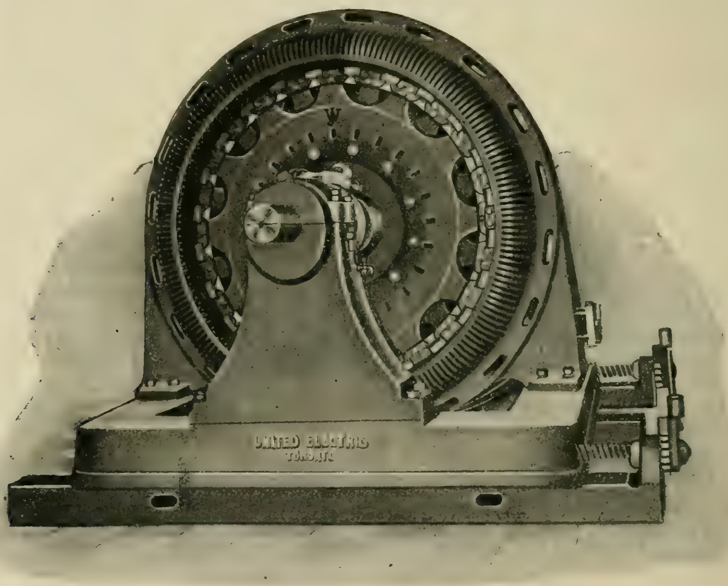


Fig. 1—New Revolving Field Alternator, W. A. Johnson Patent.

The regulation obtained is practically as close as in static transformers. Why? Because there is a definitely aligned and unchanging line of zero potential dividing the magnets and their inductive effect upon the armature, as absolutely unchangeable as the inequalities of the iron and the reversal of direction of flow in the armature circuits will admit of when using

the common type of armature as used in the present construction. (The writer's patent claims, by the way, cover an armature construction carried out on identical lines to that of the field herein more particularly described). So perfect is the regulation that the circuits of the armature may be short circuited under full excitation of the field and the armature current not rise more than 10% above normal, or such other rise as may be pre-determined by the designer, whereas in the old type if the armature terminals are short circuited at much above one half full field, then the result is an over-heated machine up to the point of destruction under full field. It immediately becomes apparent that if a generator can be short circuited when generating

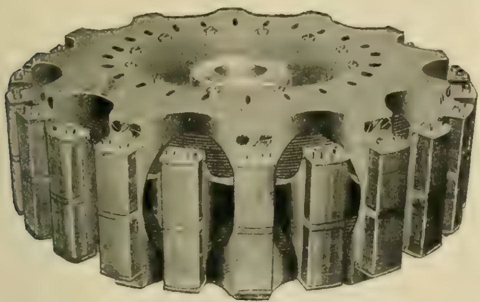


FIG. 2—NEW REVOLVING FIELD.

its rated E. M. F., that is, under its normal field excitation, that the testing of the generator under full magnetic saturation will develop the maximum capacity of the generator, that is, such a test made at the factory establishes the normal and the overload capacity beyond dispute. Generators built under the writer's patents can be short circuited by means of oil switches under full voltage up to and even beyond 10,000 volts. The above circumstances of regulation indicate that armature reactions against full field need no longer prove a bug-bear, that induction motor loads can be handled in connection with lighting load with satisfactory results. By using the same construction in motors as used in the generator, but with the addition of the short circuited bar winding for self starting, these machines allow of the highest possible power factor

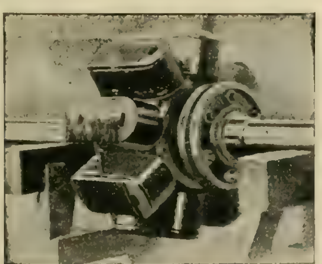


FIG. 3—OLD STYLE FIELD.

under all load conditions. The generator or motors are interchangeable, i. e., the generator can be used as a commercial synchronous motor or generator at pleasure under the most favorable conditions. Again referring to Fig. 2, it will be noted that the field coils (of which only two are used regardless of the number of poles) are wound concentric with the shaft in the line of mechanical motion and therefore the mechanical placing of the coils is facilitated. The method of building up the rotor has been much simplified in later construction than as shown in cut. As now built, the field coils are very easily accessible.

As above stated, the armature construction (see Fig. 4) as herein described is practically identical with other well known makes and is no better and no worse than theirs in any respect, using equally good material and workmanship.

As to temperature. The armature reactions common to the older types which necessarily cause counter action and again reaction and so on, in endless confusion between field and armature, are herein eliminated as in no other construction, consequently the temperature of the iron is extremely low, not 50% of the rise under similar conditions of size and output of other types, in fact, the heating of the entire machine inside the limits of carrying capacity of the copper and magnetic saturation and aside from the unavoidable eddy currents of the iron, can be considered as negligible.

The air gap between polar faces and armature iron may be as short as mechanical clearance may require and not so excessive as the older type. The efficiency is therefore very high.

At first thought it may be contended that the copper winding of the field might require to be heavier, but this is counter balanced by the decrease of the air gap and the peculiar qualities of the field which allows a heavier exciting current without corresponding increase

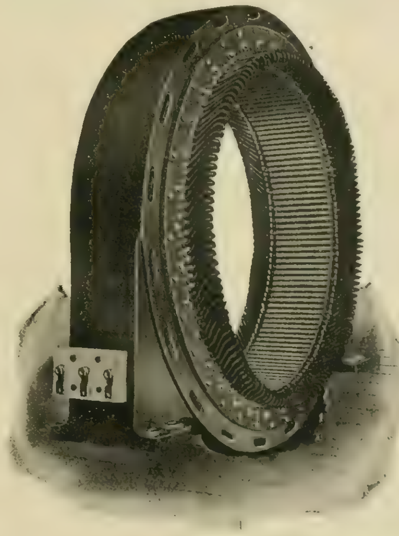


FIG. 4—ARMATURE.

in temperature for same capacity in the copper. The good regulating qualities of this machine do not end at the terminals, as it is a well known fact that all reactions within the generator are reflected in the circuits, and instead of a smooth current in the line the contrary is the usual case with the old type and the results are shown in the static discharge and broken down transformers.

The writer feels warranted in making the statement that it seems impossible to build an electric machine with more than two or less than two energizing coils and get the highest results, and as he has designed, built and been granted patents in various countries for inductor alternators and commutating machines embodying this same principle, he knows that the rule works not only both ways but three ways, that is, in the three commercial machines universally manufactured, the revolving field alternator, the inductor alternator, and the direct current multipolar dynamo.

As regulation means you can use efficient lamps, and on account of the economical generation of the current within the generator, the writer is prepared to undertake contracts for this construction with a guaranteed saving in operation to the purchaser of from 10 to 15 on the cost of generating plant.

These machines are manufactured in Canada by The United Electric Company, of Toronto; negotiations are under way for their manufacture and sale in the principal countries where patents have been granted to the writer.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Electric Cooking and Heating

So far as the invention of apparatus for utilizing for domestic purposes the heat generated by electric energy is concerned, the list today is almost complete, for a glance through any of the catalogues of the numerous manufacturers leaves practically nothing to be desired. The apparatus has long since passed the experimental stage, and at the present time it offers a method of culinary preparation which is both clean, quick, and highly efficient. Lest our use of the words "highly efficient" be misunderstood, we desire to explain that efficiency, when spoken of in connection with electric cooking apparatus, is based on comparisons between the amount of heat contained in the energy, and the amount which is actually taken up by the food. It is, one might say, an electrical efficiency. For instance, the ordinary kitchen range is the most inefficient cooking apparatus in our possession, for of the total heat in the fuel, but 2% is utilized by the food; of the balance, 12% is wasted in obtaining a glowing fire; 70% goes up the chimney; and 16% is radiated into the room. With a properly constructed electric oven, as high as 90% of the energy is taken up by the food. Referring to our editorial of last issue under the heading of "Conversion of Energy," we noted that the loss in converting coal into mechanical motion is very great If we figure the loss of all the items with the exception of that which occurs in the motors, or in other words, estimate the loss in converting the coal energy into electric current delivered by the transformers, we find that this electrical energy is 7.27% of the original. If an electric oven has an efficiency of 90%, then it will utilize a little more than 6½% of the energy in the fuel, and this contrasts very favorably with the ordinary cook-stove, where in spite of the fact that the fuel is burned direct, but 2% is used as already noted. If one means of cooking has an efficiency more than 300% greater than another, is it not worthy of consideration? But the difficulty of the matter lies in the fact that figures are deceptive—particularly those which we have given above. They are approximately correct as far as they go, and are to be valued accordingly, but beyond giving a comparison between the amount of fuel consumed with the two methods, absolutely no other item is taken into consideration. For example, let us figure the cost of heating a house by a coal furnace and by electric heaters. For simplicity consider that the first cost and maintenance of the two systems are the same, and then interest, depreciation and insurance can be left out. If one hundred pounds of coal be burned in the furnace per day, the cost of the fuel, at $6 per ton, is 30 cents. Add to this labor at 20 cents, and the total cost is found as 50 cents. Assume that the furnace has an efficiency of 50%, and then the amount of coal which actually is used in the heating is 50 pounds. The equivalent of this is 205 kilowatthours, and if the cost of current be 6 cents, the cost of heating for the day will be found to be $12.30 as against 50 cents for the other method. Electrical cooking and heating apparatus offers so much in the way of quickness and convenience that its high operating cost is often more than offset. When our water powers are more developed, and the cost of current is correspondingly reduced, we may feel reasonably sure that electricity will play an important part in the ordinary affairs of our everyday home life, and in the meantime, it is very satisfactory to note that the annual output of the apparatus is being steadily increased.

Street Lighting Questions.

About this time of the year seems to be favored for the taking up and subsequent dropping of questions re municipal street lighting. Perhaps the men in whose hands the reins of government have just been placed feel it their duty to investigate such matters, but whatever the cause, the problems are often soon dropped, and very rightly. A plant from which energy for arcs and incandescents is charged to a municipality at cost, will certainly be the means of reducing the tax rate, but the great difficulty is to keep the operating cost of such a plant, when under civic control, as low as it would be when in the hands of a competent operating company. In any manufacturing business, and the production of electrical energy can certainly be classified under such a heading, the most careful management is required to make that business a paying one. Even a little carelessness will change the margin of profit into a serious loss, and considering this, surely it is not hard to understand why most municipal enterprises are failures. When the men, corresponding to the board of directors of a lighting company, are changed each year, and where they are elected without regard to their ability to handle electrical problems, it would seem almost sure that there could never be a profit from a manufacturing enterprise placed under their control. The municipal ownership idea may be all right, and a paying one, if the management of the plant be placed in the hands of a single competent man, and left there. But where politics enter into the situation, then the idea seems hopeless, because with each incoming council, there will always be at least one man who looks upon the executive ability of that body, and particularly of himself, as being something of an exceptional order, and of a superlative quality. And then the single competent man loses his position, all his good work is undone, and at the end of the year the next council is confronted with a deficit. In Toronto the question is being taken up, and a thorough investigation may result. It is doubtful, however, if the matter will ever come to anything, for the city has a very low rate per arc lamp per year, and the service is of the all-night, every-night order. New York is also in the throes of the same problem, and taking into consideration the fact that in New York there are more politics and pulls than in Toronto, it would be unwise to attempt to predict the outcome. The great difficulty in figuring the costs of such matters is that very few people appreciate the number of items which must be charged against the operation of a plant. In connection with the municipal plant of city of the Chicago, it was stated that the cost to the city per arc lamp per year was between fifty-four and fifty-six dollars. When an expert went into this statement, he found that the items of taxes, interest, and depreciation were not included, and showed that the addition of the excluded amounts brought the cost per lamp per year to just about double the sum previously mentioned. Following this matter, we have the fact that Chicago has recently contracted with a local company to supply six hundred arcs at a price of $103 for overhead wiring, and $136 for underground. In New York the existing prices are just a little higher than those which Chicago is now paying, though this is no doubt due to local conditions, and not to the demand of the supplying company for a larger profit. Taken all in all, the investigations have no bad effect, provided that the municipalities take no rash steps, and work under the advice and guidance of a competent expert. Then if that expert have had experience with municipal management, he will be in a position to advise his client of the exact probable operating cost. And when such figure is received, it will likely dampen the ardor which characterized the municipal movement at its inception.

Candlepower.

That statements regarding the candlepower of different forms of lights are often misleading or even worse, has been asserted from time to time in the technical press of the United States and Canada. The rating of any form of light on a candlepower basis is permissible only when the distribution is uniform in all directions, and the only lamp which actually approaches the requirement is the incandescent, and it usually falls very far short. Putting a reflector behind a flame, or a lens in front of it, does not affect the total amount of light given out, though that thrown in one particular direction may be greatly increased, and may be proportionately greater as the distance grows, owing to the fact that the rays have been bent into parallelism. The rating of searchlights and other lights in which the distribution is affected by means of mirrors or lenses should be altogether abandoned, since it means nothing at all, although it may convey the impression that a light is exceedingly powerful or can be seen at a great distance. The old idea of calling an arc lamp "2000 candlepower" was long ago modified by introducing the term "nominal," though in latter years the candlepower rating has been eliminated almost entirely. Arc lamps are and should be rated on the energy consumption, and on no other basis. It is almost impossible to get a reading on an arc lamp by means of a photometer, for when the arc proper is on the side of the carbons nearest the instrument the light is very great, and when it wanders to the other side, in the intensity is greatly reduced. Incandescent lamps when under test are revolved very rapidly, and the candlepower is read on the horizontal. Standard lamps with the usual shape of filament will approximate sixteen units of light in this direction, while what is called the downward radiation may be but six to ten. The low consumption of energy per candlepower in lamps of the Nernst and Meridian types is due to the fact that most of the light is thrown downward by means of the arrangement of the light-radiating parts of the lamps, these being set below reflecting surfaces. Photometric measurement is based on the law that the intensity of illumination at any point varies inversely as the square of its distance from the source of light, and this law assumes that the light is allowed to distribute itself freely in all directions. When the distribution is altered in any way from what is considered standard, the candlepower rating should be accompanied by an explanation of how the measurement was taken. For instance, in a searchlight the beam is made to pass out from the lamp in one direction, and its rays are very nearly parallel. Suppose that a photometer is set up between a sixteen candlepower lamp and a searchlight, and that a balance is obtained with the screen one foot from the incandescent and one hundred feet from the projector. This would indicate that the light of the latter was 160,000 candlepower. Now, if the searchlight be moved away another hundred feet the intensity will not be much reduced, as the rays of of light are nearly parallel. Assume that it is not reduced at all, and then this second reading will indicate 640,000 candlepower. The absurdity of such a system of rating is evident, and manufacturers are showing their good sense by dropping it altogether and substituting an energy basis in its stead.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. No. 1.—How do you figure the internal resistance of a storage battery? Any ordinary resistance can be found with a voltmeter and ammeter by Ohm's Law, but the storage battery gives off voltage all the time, and I don't know how to measure it.

ANS.—If you have a storage battery, a voltmeter and ammeter will undoubtedly be part of your equipment. Measure very carefully the voltage of the battery on open circuit. Then connect a load across the battery terminals, with the ammeter in circuit. Read the amperes very carefully and at the same time get a reading on the voltmeter. It will be noticed that the second voltmeter reading is a little lower than the first. Then Ohm's Law holds good—R equals E over C. R being the internal resistance of the battery, C being the current shown by the ammeter, and E being the difference between the first and second voltmeter readings. Before this test is made the battery should not be either charged or discharged for some time, and the test readings should be taken as quickly as possible. This is to eliminate errors due to polarization.

QUES. No. 2.—In view of the prevailing custom to ground the neutral of transformers, do you think the same idea could be applied successfully by grounding the armature winding of a three phase star connected generator at the centre point, using in the ground circuit a light fuse (depending on the voltage of the machine) of the enclosed type? In the event of a short circuit or heavy lightning discharge, would the winding be protected by such a scheme?

ANS.—Where the neutral of a transformer secondary is grounded this action is taken as a safeguard against the destruction of life. If a ground exist on one wire of the primary, and a breakdown occur in the transformer between the primary and secondary, then between the secondary circuits and the ground there will exist a difference of potential of almost equal the primary voltage, provided the neutral of the transformer be not grounded. If, however, the neutral be grounded the maximam voltage between any part of the secondary circuits and the ground will not exceed one half of the total secondary voltage. If, however, you ground the neutral point of the generator, it is true that the strain between any of the three wires and the ground is reduced something less than one-half, but that voltage will still be far above the dangerous point. We assume, of course, that your generator voltage is not less than 2,300. Therefore, as a safeguard, the idea would have no value—in fact, it would really increase the risk to the linemen. If a short circuit occur between two of the three wires, or even between all three of them, the ground connection with its fuse would not be in circuit. If a wire should come down, then a circuit is formed through the main fuses, and the ground fuse, and the blowing of either will break the short. In considering the advantage the scheme would have in connection with lightning discharges, it is difficult to say anything very definite. If the lightning arresters should fail to take care of the discharge, it is possible that it would pass on through the windings and go to the ground through the fuse, although the choke coil action of the generator winding might seriously impede such action. When the transmission is overhead, the scheme is seldom or ever used, as its advantage is doubtful and trouble may occur. Where underground distribution is used, with high voltages, the idea has been sometimes adopted, as it reduces the strain between the ground and the cables, transformers, etc. If it were to be considered at all, we think the fuse should be omitted entirely.

QUES. No. 3.—(a) Explain in a practical way how lubricating oils should be tested that they may be selected for electric generators. (b) What is the difference between vacuum oil as used by pumps under pressure and other lubricating oils?

ANS.—(a) The chief requirements for an oil to be used in the bearings of generators are few in number and simple. There are many methods of making tests which can be used by the refineries, but which are unsuitable for use in the engine room. Perhaps the best and most effective test is to observe the oil under operation. If a bearing which has heretofore run cool and with very little oil, suddenly heats up when a change of lubricant is made, and the heating cannot be attributed to mechanical troubles, it is pretty safe to say that the difficulty lies in the oil. Dynamo oil should not have an appreciable evaporation when hot, nor should it thicken greatly when cold. If a thin film of the oil to be tested be spread on a sheet of glass, and exposed to the free action of air, evaporation may be easily noted. Oils of the vegetable class evaporate rapidly (comparatively speaking) and are therefore seldom suitable for use in generator bearings. Viscosity is another requirement. The best definition of this word is "stickiness." An oil may be very thin and yet have high viscosity. Pour a little oil on a sheet of glass and then hold the glass vertical. The bulk of the oil will run down and off at once if it be sufficiently thin, but a thin film will remain, and go off but slowly, depending upon the stickiness of the oil. The flashing point of oils used for lubricating bearings is comparatively high, and therefore it is seldom that a test of this feature is required. (b) The name "vacuum" is a trade-mark word applied to the product of the Vacuum Oil Company, which is a branch of the Standard Company. So far as we know there is no special treatment given this oil which merits the name vacuum, though constant use of the word has caused some confusion on this point. Practically any thin oil may be used for the purpose you mention, except possibly where some special requirement makes the use of a special oil necessary.

The report has been published during the past month that the New York Central Railway has secured control of the Buffalo Street Railway, the Niagara, St. Catharines and Toronto Railway, the Hamilton, Grimsby and Beamsville Railway, and the Hamilton Radial Railway, and that all the roads would be amalgamated. While it is probable that some negotiations of this nature are under way, it is not believed that a definite agreement has been reached.

WESTERN REPRESENTATIVES OF ELECTRICAL COMPANIES.

The rapid development of the Canadian Northwest is creating a large demand for electrical apparatus of all kinds. The municipalities of the West are progressive and desire modern methods of lighting, and in nearly all instances electricity is being adopted. The manufacturers of electrical machinery and supplies recognize the importance of this market, consequently we find as their western representatives men of exceptional activity and vigor and at the same time good business ability. We publish below the portraits and a few particulars of the Winnipeg representatives :

Mr. G. A. Powell.

Mr. G. A. Powell is the western manager for the Packard Electric Company, Limited, of St. Catharines, Ont., with offices at 31 Canada Life Building, Winnipeg. Mr. Powell has been associated with the company in various important positions since its inception some fourteen years ago, and is well known by the electrical fraternity in Eastern Canada. The territory now under his charge extends from Port Arthur to the Pacific Coast.

Mr. B. G. McBurney.

Mr. B. G. McBurney, who has recently been appointed Western Canada representative for the Canadian General Electric Company, was born near Toronto and has lived in Canada the greater part of his life. He entered the electrical field in 1889 as an employee of the Edison Electric Company, of Schenectady, N. Y. Later he went into the electrical contracting business, making a specialty of installing apparatus. He afterwards became the Ontario representative for the Walker Company, manufacturers of electrical apparatus, Cleveland, Ohio. Eight years ago he entered the Agency Department of the Canadian General Electric Company, being appointed their western manager about two months ago.

Mr. William E. Skinner.

Mr. William E. Skinner, district manager and western representative of the Westinghouse Company for Manitoba, has his headquarters in the Union Bank Building, Winnipeg. He has been with the Westinghouse Company for thirteen years, having graduated in their shops at Cincinnati. Since then he has represented the company in Buffalo, Niagara Falls and Honolulu. From the warm climate of Hawaii he came through to the more vigorous climate of North-Western Canada. While in Hawaii Mr. Skinner was elected treasurer of the Honolulu Engineers' Association. He is an associate member of the American Institute of Electrical Engineers, is thirty-five years of age, and a splendid representative of the Westinghouse interests.

Mr. L. J. Belnap.

The western representative of Allis-Chalmers-Bullock, Limited, is Mr. L. J. Belnap, who has his headquarters at Winnipeg. Mr. Belnap has had a long engineering experience, both electrical and mechanical, having been connected with several large manufacturing companies. He has been on the expert construction staff and superintended the installation of some of the most important electric light and power plants in Canada which have been built by the Allis-Chalmers-Bullock. He was district engineer for the Company at Montreal and later engineer of the sales department at that city. In April, 1904, he was appointed district manager at Winnipeg.

AN OTTAWA INSTALLATION.

The Ottawa & Hull Power & Manufacturing Company are supplying power over their new 12,000 volt transmission line. Herewith we show an illustration of the step-up transformers, air chamber blowers, etc., designed and installed by their consulting engineer, Mr. R. S. Kelsch, of Montreal. The International Cement Company will take 3500 horse power to operate the new cement works, which are said to be the finest on this continent.

A UNIQUE INSTALLATION.

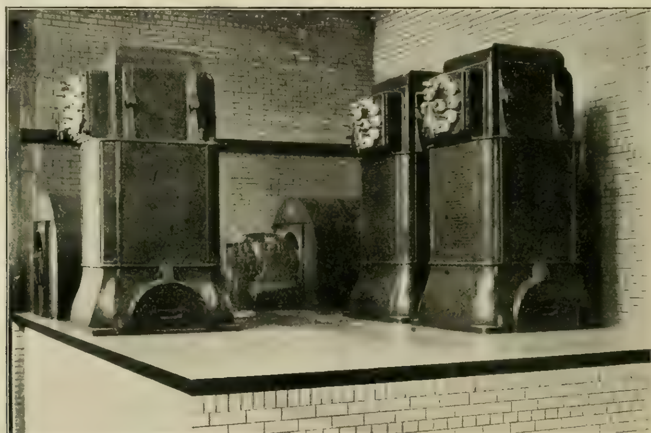
By J. F. H. Wyse.

The plant recently installed by the Parisian Laundry Company at the corner of King and Portland streets, Toronto, has several features of interest which make it worthy of attention and of possible help, in the way of a model, for any company contemplating a like enterprise. The building is of white brick throughout, being 150 feet long by 66 feet wide, and fronting on King street, with four floors including the basement, amply supplied with windows and finished inside in white, so as to get absolutely the best lighting effects. The proprietors of this establishment, Mr. David and Mr. Robert Morton, seem to have appreciated the fact that white absorbs only about 15 per cent. of available light.

At the north side in the rear of the building is located the boiler and engine room and the generating plant. The boilers are of the tubular type, two in number and about 125 h.p. each, and are equipped with the latest smoke consumers of the simplex type. The engine is of the well known Wheelock design. This part of the plant was built and installed complete by the Goldie & McCulloch Company, of Galt.

All of the laundry machinery, which is used in connection with an amount of water, is located in the basement over drains in the concrete floor connecting directly with the city sewerage system, and is driven by counter shafting belted to the engine. The Turnbull elevator, connecting the four floors, is driven in the same manner.

The electric plant consists of two 17½ k.w. direct current, belt driven generators, 1175 r.p.m. and wound for 250 volts. The connections are so arranged at the switchboard that they may be operated either together in multiple, on both the lighting and power circuits, or separately on both, or either machine may be worked separately on either lighting or power circuit. These machines with switchboard and a 5 horse power motor, operating a line shaft for dryers and starchers, were furnished by the Canadian General Electric Company. The wiring, contract for which was let to Messrs. H. F. Strickland & Company, of Toronto, is laid out for one per cent. drop. The lighting circuit consists of two No. 4 B. & S. stranded R. C. cables in Richmondt conduit, distributing from blue Vermont marble panels to four branch mains of No. 8 B. & S. R. C. stranded cables, also in Richmondt conduit, on each floor, and to 220 volt 32 c.p. lamps, arranged on the ceiling with 12″ mirror reflectors. The power circuit consists of two No. 2 B. & S. R. C. stranded cables connecting through iron junction boxes with No. 6 B. & S. branch mains, run on the under side of each floor, through which they rise, all in Richmondt conduit, to individual motors. All conduits are furnished with water tight joints, and hermetically sealed.



Step-Up Transformers, Air Chamber Blowers, Etc.—Ottawa & Hull Power Company.

With the exception of the washing machines in the basement, every separate machine is driven by an individual motor, geared directly to suit the speed of that particular machine.

When this individual drive was at first contemplated, Mr. Morton insisted that the motors must all be geared to do away entirely, or as far as possible, with dust or anything like belts that might accumulate or convey dust. When the speeds of these machines were consulted with relation to the amount of power required, we found there were four sleeve band ironers taking only ⅛ of a horse power each, and working at 72 r.p.m.; two mangles taking two h.p. each at 85 to 300 r.p.m.; a yoke ironer at ⅛ horse power and 90 r.p.m., and so on, covering in all some thirty small motors required, of low and variable speeds.

Careful inquiry among manufacturers of standard electric apparatus seemed to reveal nothing that would meet the requirements. In the United States we found where several of the large electric manufacturers had attempted with failure the equipment of laundry machines, and it looked very much as though the project would have to be abandoned, or special

motors in each case designed with their different control as to speeds, and special gears. A few figures in connection with tee mechanical features of this proposition convinced us that it would run into entirely too much money, and it was abandoned. Shortly after this we found The Mechanical Appliance Company, of Milwaukee, Wis., had equipped some similar machines in the United States with Watson motors. Further inquiry convinced us that these motors were giving satisfaction and the contract was awarded the Mechanical Appliance Company. These motors are wound for 220 volts and in almost every instance the machines are self-contained, the motor being mounted either on the base or frame of the machine.

This plant illustrates how the tremendous loss of distribution by shafting may be saved, and how laundry work is done on a large scale, and in a most up-to-date way, and besides has the distinguishing feature of being the first and at present the only plant of the kind in Canada.

A LARGE INDUCTION REGULATOR.

The Montreal Light, Heat & Power Company have installed in their Maisonneuve substation an immense induction regulator, which is shown herewith. It is believed to be the largest piece of apparatus of the

Induction Regulator Installed in Montreal Light, Heat and Power Company's Sub-Station.

kind in the world. The regulator has a capacity of 5000 amperes at 2400 volts, designed to raise or lower the pressure 10%. The regulator will be used in connection with the permanent plans of consolidating the Montreal Light, Heat & Power Company's two phase 66 cycle system with the Lachine Rapids Hydraulic & Land Company's 60 cycle three-phase system, which plans have been designed by and are being carried out under the supervision of Mr. R. S. Kelsch, the company's consulting engineer.

At a meeting of the Engineers' Club of Toronto, held on March 23rd, Mr. K. L. Aitken, consulting engineer, presented a paper entitled "The Relation between High Tension Lines and Other Lines." A large number of members were present, and the paper was followed by an interesting discussion.

THE LATE LEONARD E. DYE.

The Winnipeg electrical world recently sustained a loss in the death of Mr. Leonard E. Dye, which occurred on Sunday, March 19th. Deceased had been living in Winnipeg since 1900, when he took charge of the electrical work of the E. S. Harrison Company, Limited. Prior to that time he was in the employ of the General-Electric Company at Minneapolis, as expert in charge of their arc lamp department. In February, 1904, Mr. Dye left the Harrison Company and started the Winnipeg Electric Company, but later severed his connection with that concern to accept a position with the Hudson Electrical Supply Company of Winnipeg, which he held up to the time of his death. He was only 34 years of age, but was recognized as one of the best electrical engineers in the city and was instructor at the electrical engineering classes conducted at the Y.M.C.A. The students of his class acted as pall bearers and his fellow employees at the Hudson Electrical Supply Company followed the funeral.

WINNIPEG POWER DEVELOPMENTS.

The Winnipeg Street Railway Company are pushing forward to completion their water power development works at Lac du Bonnet and it is expected that electric power, generated at these works, will be transmitted and put to use in Winnipeg before the close of the present year.

Another company has been organized to utilize this water power, and it is said that this company have sold debentures to the amount of one million dollars for this purpose, and that as soon as these debentures are printed and signed the scheme will be proceeded with. The citizens of Winnipeg feel that one of the greatest needs of the city at the present time is cheaper fuel for manufacturing purposes, the present cost of fuel being almost prohibitive. If the scheme undertaken by the Dominion Government a year or two ago for the improvement of the Winnipeg River is carried out, it will place at the disposal of the citizens of Winnipeg a plentiful supply of wood for fuel and building purposes, from Lake Winnipeg, which under present conditions can only be obtained for a very short time each year, during the period of high water.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

The annual convention of the Canadian Association of Stationary Engineers will be held in the city of Chatham, Ont., August 22nd, 1905, and it is expected that the attendance will be larger than usual, as the question of legislation will likely be discussed at some length. The engineers have prepared a bill, to come up at the present session of the Ontario Legislature, to regulate the qualifications of engineers in charge of steam plants. They desire that every engineer operating a plant of 25 h. p. or upwards should be compelled to hold a duly certified certificate from a board of examiners, consisting of at least three qualified persons, appointed on the recommendation of the Minister of Agriculture. The need of some legislation along this line is very apparent. During the past two years there have been 21 boiler explosions in the province of Ontario alone, by which over thirty persons were killed or wounded. On marine engines, which are under Dominion Government supervision, there has been but one explosion in 23 years.

At a recent meeting of the Stationary Engineers' Association, Victoria, B.C., an interesting paper on "Vacuum" was read by Mr. M. Hutchison.

Messrs. P. E. Marchand & Company, 128 Sparks Street Ottawa, are installing an electric plant at Papineauville, Que. The power will be transmitted 15 miles for lighting the villages of Papineauville, Montebello, St. Andre Evelin, and Thurso. They are putting in a 150 k.w. generator and expect the plant to be in running order by June 1st. In the course of a year or two they expect to extend the plant to take supply several neighboring towns. The same parties are installing a plant at Maniwaki, where they are putting in a 250 k. w. generator, three-phase five miles transmission, to be completed by the first of October There is a fine water power there and it is intended to furnish light and power to several municipalities in the district.

JANDUS SERIES ALTERNATING ARC LIGHTING SYSTEM.

The Jandus Electric Company, Cleveland, Ohio, manufacturers of enclosed arc lamps,have put upon the market a new system of series alternating arc lighting, which has several features of great interest.

The illustrations show the arc lamp, the regulator and a special arrangement of regulator and switchboard panel. These and many details relating to the system are described and illustrated in Bulletin No. 21, issued by the company.

The lamp, Fig. 1, is of the widely known Jandus interchangeable type, the casing, glassware and main body being identical with Jandus lamps for all the classes of service now in use, both alternating and direct current, the integrally mounted mechanisms being interchangeable. The interchangeable feature is obviously of great value to central stations using a variety of circuits, as all lamps may be uniform in appearance and structure, with the same inner globes and carbons, and all repair parts identical excepting those forming part of the interchanged actuating mechanisms. The lamp has a differential mechanism, and the regulation claimed for it is very fine. All details are worked out with the same skill and care that have characterized the work of the Jandus Company in past years. This lamp won the highest award (gold medal) at the World's Fair at St. Louis. The long burning life of the lamp—140-175 hours—is specially notable.

Fig. 1.—Jandus Series Alternating Current Arc Lamp.

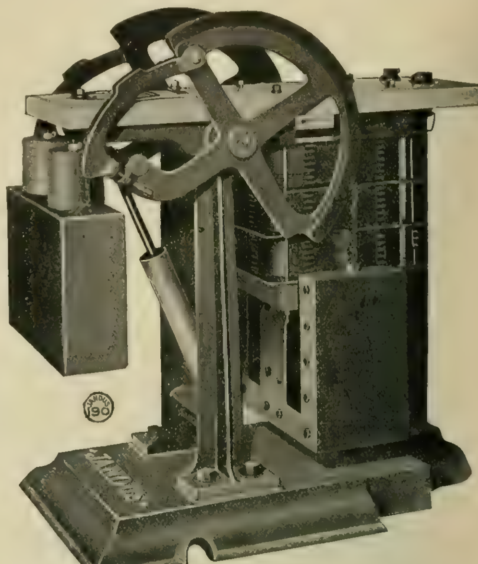


Fig. 2.—Jandus Series Alternating Current Regulator.

The regulator, Fig. 2, is perhaps the most interesting feature of the system. It is of the inductive type and is designed on novel lines. It consists of a baseplate and a vertical frame upon which is mounted a heavy marble top. This top carries the terminal binding-posts and supports the inductive coil. The purpose of this construction is to insulate all the current-carrying parts thoroughly from ground. The coil is stationary so that no flexible leads are required. The core is movably mounted to operate vertically into and out of the stationary coil. A weight is connected to the movable core by means of steel chains located in grooved wheels which are mounted on finely finished ball bearings. The weight serves to counterbalance the core when the coil is not energized. Through the medium of an adjustable cam on the counterweight side of this system of forces the moment is made inversely proportional to the magnetic force which actuates the core. The coil is constructed of fire and moisture-proof wire and the insulating heads are of mica, so that the regulator will withstand a short-circuit for an indefinite period.

Fig. 3 illustrates a special feature of the Jandus system whereby the regulator and switchboard panel are installed as a unit, which of course may be multiplied in the central station. This arrangement saves largely in floor space, but its particular advantage consists in compacting all the apparatus necessary to be observed and manipulated and in installing it within reach of the attendant. In such an installation the operator has before him and within reach every part of the regulator and every switchboard instrument, so that without changing his position he can make all neces-

sary observations and adjustments in starting the circuit.

The following claims are made as to the advantages of the Jandus type regulator:

Current-carrying parts suspended from marble and thus thoroughly divorced from ground; elimination of frictional retardations by use of perfect ball bearings; fixed coil and movable core, this arrangement requiring no flexible connections which are frequent sources of annoyance; disposition of the counterbalancing weight within the parallelogram of the base, this sav-

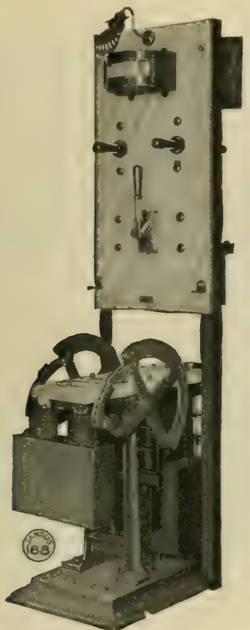


FIG. 3—JANDUS REGULATOR AND SWITCHBOARD PANEL INSTALLED AS A UNIT.

ing floor space and eliminating the projecting arm, which is often in the way of the station operator; harmony of design with switchboard panel, permitting the installation of the regulator and switchboard as a unit; an indestructible coil capable of withstanding a short-circuit indefinitely.

The Packard Electric Company, St. Catharines, Ont., are the Canadian representatives of the Jandus Electric Company and will be glad to furnish any further particulars desired regarding this new lighting system.

GERMAN REGULATIONS FOR HIGH-TENSION OVERHEAD WIRES.

The regulations of the Verband Deutscher Elektrotechniker as amended last year include a number of rules for high-tension overhead wires and cables, the chief points in which we give briefly below :—

All installations come within the range of the high-tension regulations, if the effective pressure between any conductor and earth is (or may be through an earth) more than 250 volts.

Overhead wires must be bare, but where they are exposed to detrimental chemical action they may be provided with a coating of protective paint.

The insulation of overhead wires in damp weather must not be less than 80 ohms per volt and kilometre (128 ohms per volt and mile) but need not exceed 1,500,000 ohms. Generating plants are to be provided with means for measuring the insulation resistance during actual service.

Overhead wires must have a cross-section of not less than 10 sq. mm. (0·0155 sq. in.).

The insulators must be of porcelain, glass or an equivalent material, and, when used for voltages above 2,000 volts, they are to be tested at the factory to at least double the working voltage. The insulators are to be used in an upright position only.

Earth connections are to be soldered, the only exception being when earthing switches are used, in which case the connections may be screwed to the switch and the object to be earthed. Wire netting, perforated or unperforated metal sheets, or similar materials are to be used as earth plates, and pipework may form part of the earth connection, but must be supplemented by such earth plates.

Supports and guarding devices of overhead conductors, the voltage of which to earth exceeds 500 volts, must be marked by a red zig-zag.

Overhead wires must be at least 6 metres (20ft.) above the ground in ordinary positions and at least 7 metres (23ft.) when crossing highways. The span and sag of overhead wires are to be such that the factor of safety against breaking is 10 in the case of wooden poles, and 5 in the case of iron structures. At—20°C. (—4°F.) the tensile stress in the overhead conductors must not be more than one-fifth (or one-third in the case of hard-drawn metal) of the breaking stress.

Overhead wires and apparatus must be inaccessible without special means.

In inhabited places the overhead wires must be provided with section switches which may be operated during actual service.

In inhabited places and grounds and in the proximity of roads, where falling wires might endanger life, the wires are either to be placed so high that, upon breakage, the wire ends hang not less than 3 metres (10ft.) above the ground, or the falling of the wires must be prevented by guards, or means must be provided for causing the fallen parts to become "dead." Provision is to be made at corners of the transmission line for preventing the wires from dropping should the insulators break.

Where the pressure exceeds 1,000 volts, the anchor wires are to be fixed to the poles with the interposition of an insulator, and the point of attachment to the pole must not be less than 3 metres (10ft.) above ground.

If iron poles are used which cannot be well earthed, the pole is to be surrounded (but not touched) by wood or a material having similar insulating properties, to a height of 2 metres (6½ft.) The earth conductor of the lightning rod must be treated in a similar way.

Where the wires run along the outside of buildings, the distance per 1,000 volts between wall and wire must not be less than 1cm. (0·4in.). The total distance must be at least 10cm. (4in.).

H. W. Beveridge, of Andover, N.B., James Burgess, of Grand Falls, N.B., and others, have been incorporated as the Provincial Telephone Company, Limited, to construct and operate telephone lines in the counties of Madawaska, Victoria, Carleton, York, Restigouche and Northumberland, N.B. The proposed capital stock is $10,000.

TELEGRAPH and TELEPHONE

THE INDEPENDENT TELEPHONE SYSTEM AT NEEPAWA, MANITOBA.

There have been established up to the present time but very few independent telephone systems in Canada. The first municipality to enter the field against the Bell Company, to successfully maintain a public service system, is the Town of Neepawa, Manitoba. This town has, at the present time, about 1,600 inhabitants and is in one of the most prosperous and rapidly growing agricultural sections of the Dominion, about 100 miles west of Winnipeg. The decision to establish a municipal telephone system was reached as far back as 1899.

The committee having the establishment of the exchange in charge, aimed to fix the basis of service rentals upon a purely maintenance basis. This was done so that the subscriber of the system would not be required to pay into the city treasury to the benefit of the non-user, but that they might pay a sufficient rate so that the rate-payers of the town who did not use the system would not be required to bear any of the expense or responsibility of the system. A charge of $12 per annum for domestic service and $24 per annum for business use was decided upon.

While the exchange started with but a small number of patrons, the municipality equipped the central office with a capacity for 150 lines, intending to provide for all future demands. The reasonable rentals charged soon resulted in a large increase in the number of subscribers. About a year ago the demand for the service from new subscribers far exceeded the capacity of the plant, and in order to accommodate the requirements it was necessary to greatly extend the system and enlarge the plant.

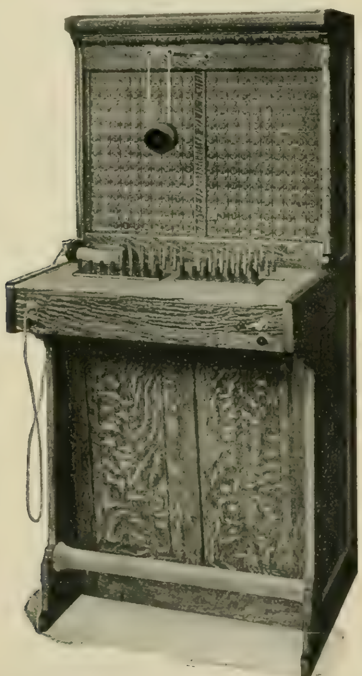


Fig 1—Neepawa Telephone Exchange Front View of 200-Line Section of Switchboard.

When the exchange was first installed, it was equipped with a manual restoring drop switchboard with shutters for indicating to the central the subscriber's call, and with the subscribers' instruments of the individual generator-call and local battery type, of a French manufacture.

Under the great development of telephone systems during recent years, the apparatus as originally installed at Neepawa was of a very antiquated type as compared with present systems. To give its patrons the most convenient and reliable service obtainable, the Municipal Council, on April 29th last, decided to not onty enlarge the service, but also at the same time to thoroughly modernize its plant by putting in a full central energy system, so that the subscribers might signal the central office automatically by taking the receiver off the hook, and so that the disconnect signal would be automatically given when hanging up the receiver, and also so that there would be no batteries at the subscribers' telephones, but having all the batteries located at the central office.

The day after the council had passed the resolution for modernizing and enlarging the system, the town unfortunately sustained a severe loss through a heavy flood destroying one of their water-power dams, which it was necessary to replace at once. With this unexpected expense, the town was required to reduce all other appropriations, including a reduction of the telepeone appropriation, to such an amount that it would be impossible to entirely re-equip the system as well as extend the service.

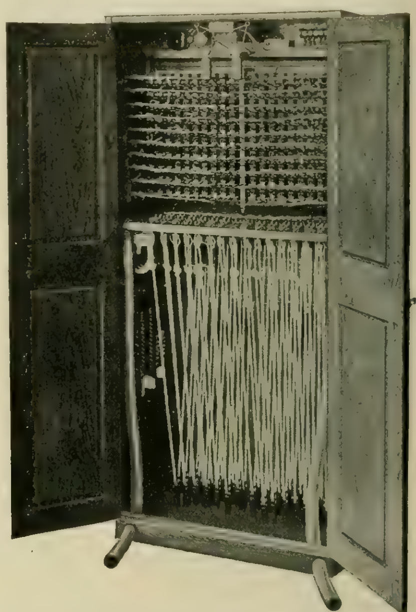


Fig. 2—Neepawa Telephone Exchange—Rear Interior View of Switchboard.

It was absolutely necessary, however, in order to meet the pressing demands for service, that the system be extended at once, which necessitated increasing the central office apparatus as well as increasing the number of outside lines.

Apparatus of all the principal makes of European manufacture and all of the independent manufacturers of the States were thoroughly investigated, and tenders, with samples of the apparatus proposed, were called for. After a careful comparison by their electrical engineer of all of the samples of equipment submitted, and a consideration of the tenders submitted, the contract was awarded the International Telephone Manufacturing Company, of Chicago, including the rebuilding of the outside construction and also including the erection of a large quantity of lead-covered cable and terminal boxes.

The system proposed by the International Company was especially adapted for the peculiar situation there, as it enabled the municipality to make provision in the equipment installed at this time so that it will be necessary only to re-equip the central office and allow the equipment to be changed to the central energy system at any time in the future, without discarding any of the apparatus installed at this time.

This is a system entirely new in the telephone field and a brief description will be of interest to those contemplating the re-equipping of old exchanges or the building of new plants where it is impossible to install an entire central energy system at first, but where, in time, it may be desirable to change to central energy.

Fig. 1 shows the front view of a 200 line section of "International" self-restoring drop switchboard. The drop is of the tubular type, constructed of a magnet coil with fine silk-covered

magnet wire wound over a soft iron core, with the spool encased in a soft iron tube to eliminate entirely all cross-talk or induction between the lines in the switchboard.

The drop armature is pivoted on the rear of the drop and is provided with a long pin forming a latch through the shutter at the front of the board, so that at the slightest impulse of the generator at the subscriber's instrument, the shutter is unlatched and indicates the call. A small trigger is placed in the spring jack in the path of the plug, and so arranged that when the plug is inserted into the jack, the trigger automatically restores the drop shutter. The restoring trigger is mounted on a heavy German silver compensating spring so as to make the restoration of the shutter positive at all times, even after long-continued usage. These combined drops and jacks are mounted in rows of ten, on

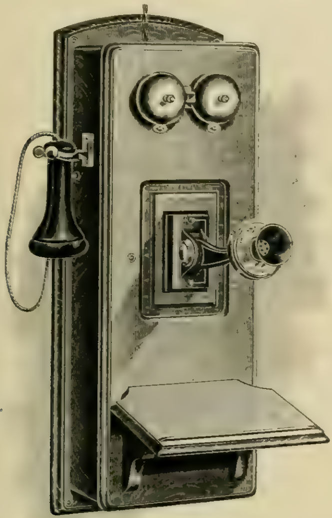


FIG. 3—NEEPAWA TELEPHONE EXCHANGE LONG DISTANCE WALL TELEPHONE.

heavy steel strips properly insulated with mica sheet and hard rubber screw bushings.

The line equipments are held in position on the strip by lhe ferrule of the jack which screws into the jack base, firmly clamping these parts. These line equipments may be readily removed with a friction wrench placed in the jack ferrule on the front of the board. In this way the jack ferrules may also be readily removed and replaced, if necessary, after becoming worn from long-continued usage. The strips of ten line equipments are each mounted on the front of the board on a heavy steel frame, properly braced to make the board strong and rigid. The clearing-out drops or "disconnect" signals are placed in the bottom row and immediately above the cord circuits.

The board is equipped with fifteen pair connecting appliances, each pair consisting of a ringing and listening key with ring-back key, a pair of plugs, cords, pulley weights, cord terminals and necessary wiring. The plug shelf is covered with heavy belt leather to provide a cushion for the plugs when returned after disconnection, and also to prevent the top of the board from being marred by the continual impact of the plugs. The plugs are compact, but are of sufficient size to enable making every part strong and durable. Each plug is provided with an insulating sleeve so mounted that it will turn the plug body, so that when the operator twists the plug when inserting into the jack, it will not break and kink the connecting cord, which greatly reduces the strain on these parts.

The combination ringing and listening keys and ring-back key are compactly mounted upon one base. The long key, shown toward the front of the board, is a regular ringing and listening cam. It is so connected that when an operator inserts a plug into any of the subscribers' line jacks and presses the corresponding cam toward the board, it throws in and connects the operator's instrument with that particular line. After the mate plug is inserted into the line jack of the subscriber wanted, and the key is pulled toward the operator, it cuts in the generator and rings the subscriber's bell. When the key is in the ringing position, it is automatically restored when the operator releases the pressure on the cam. The key may, however, be locked in the listening position so that an operator can carry on a long conversation with a subscriber, if necessary, without holding the key in position.

When it is desired to ring back on the line originating the call, the small button back of the regular ringing cam is pressed toward the board, which throws the generator on the answering cord. This combination key is so constructed that it requires but one set of main ringing springs, making two less springs and four less contacts than any other key of its kind now in use. The keys are provided with long and heavy springs, punched from the highest quality spring German silver sheet. The springs are provided with genuine platinum contacts.

Fig. 2 shows an interior view of the rear of the switchboard, showing the wiring of the line equipments, the night bell, the operator's instrument induction coil, the central energy coil, the cord circuits, etc. As constructed and used at the present time, it is for generator-call and local battery system. At the top of the board, between the night bell and induction coil on the central energy coil, is shown a card reading "Take short off this coil for central energy." This is the only work required for changing this switchboard from a magneto-call local battery system to a complete central energy apparatus, in addition to connecting the central energy wires at the line equipments, which are provided with screw terminal wire clips so that the change may be readily made.

This system enables the municipality to temporarily use their old individul generator-call and local battery instruments and at any time in the future, when it is deemed advisable to change to central energy, they can alter the system without discarding any of the apparatus of the new style installed, but by simply adding the central office battery plant and replacing the old instruments with central energy telephones.

Fig. 3 shows the long distance wall instrument of the "International" type that are being installed in the increase of the system and for replacing the old apparatus as required. These telephones are equipped with a granular carbon type transmitter with a very fine and reliable adjustment so they may be adjusted sensitive for quiet office and residence use, and slightly deadened for machine shops or other noisy places. The receivers are of the horse-shoe magnet bi-polar type, with all of the metal parts self-contained and entirely enclosed in a hard rubber shell and cap, no parts of the receiver depending on the shell for holding the adjustment.

The transmitter arm is of the long extension type, arranged so that the transmitter may be raised or lowered to suit the convenience of the user. The base of the transmitter arm is provided with a sub-base which is permanently mounted on the wood-work and supports the connecting clips and the wiring of the arm, and holds the transmitter arm in place by means of two heavily nickle-plated machine screws, which avoids unscrewing the base from the backboard when inspecting the instrument.

The transmitter circuit is taken directly from the front and back electrode of the transmitter, through insulated conductor cord, direct into the instrument to the induction coil, thus avoiding using any part of the transmitter or arm for completing one side of the circuit.

The generators are strongly constructed and very powerful in their action, insuring the indicating of the central office signal at every call upon properly constructed lines. The generator is provided with an automatic shunt so that it is automatically thrown in when operated.

The complete telephone has all connecting wires, binding posts and terminal screws fully concealed within its cabinet, so there is no liability of the parts becoming accidently disconnected and no exposed metal parts form any part of the circuits at any time, avoiding danger to the user from lightning or crossed lines with other electrical circuits, while using the instrument.

With all of the instruments in service for which there is a present demand, the municipality of Neepawa will have in operation over 180 subscribers, which shows one instrument for less than every nine inhabitants.

The Bell Telephone Company have purchased a site on west side of Mountain street, near St. Catherine street, Montreal, on which to build a modern up-town exchange.

Messrs. Benjamin Matthews, Aaron Sherk and John Baer, of Ridgeway, Ont., are establishing a telephone system connecting the villages of Port Colborne, Ridgeway and Fort Erie.

INDUCTION MOTORS.

Mr. H. A. Burson, M.Sc., chief electrical engineer of Allis-Chalmers-Bullock, Limited, Montreal, recently delivered to the students of electrical engineering at McGill University a series of addresses upon "Induction Motors," the manufacture of which the company make a specialty. The lectures were of an introductory character and discussed the theory of the rotating field in alternating current apparatus.

He first took up the winding of induction motors of different types and showed how the different distribution of stator winding affected the total magnetizing field, and described the relation of the maximum value of the induction to the average value. Some authors hold that the field distribution is as a sine wave, but Mr. Burson's experience was that it is not, but is a wave of such shape that the relation of the maximum to the average value is greater than that given by the sine wave.

Taking up the theory of the vector diagram as first propounded by Mr. B. Behrend, chief electrical engineer of the Allis-Chalmers Company, Milwaukee, he showed how the diagram for induction motors differed from that of alternating current transformers without leakage in that the locus of the end of the current vector lies on a circle, instead of on a straight line. This is due to the leakage which is necessarily present in induction motors.

He then took up the leakage factor—one of the most important features of induction motor design, about which, however, little is generally known—and showed that the leakage factor depended on the pole pitch, the width of core and the length of air gap. He also described the relation of the leakage factor to the magnetizing current and the diameter of the circle diagram, viz., that the diameter of the circle diagram is equal to the magnetizing current divided by the leakage factor.

Returning to the circle diagram he showed that the maximun power factor obtained from a machine depends directly on the value of the leakage factor and that hence the aim of the designer is to so construct a machine as to have as small a leakage factor as possible. The relation of the leakage factor to the over-load capacity was dealt with and it was shown that for the same magnetizing current an increase of leakage factor means a decrease in the over-load capacity of the motor.

Mr. Burson finally showed how to take into account the primary and secondary resistance losses and the iron losses, according to the method originated by Mr. Behrend, which he strongly recommended because of the simplicity of its application.

The town of Milton, Ont., has retained Mr. K. L. Aitken, of Toronto, as their consulting engineer in connection with the rebuilding of their electric light plant. A new power house will be built, and boilers, engine, generator, and switchboard installed. In all probability the system of distribution will be materially changed.

MUNICIPAL LIGHTING PLANTS.

The City Council of Calgary, N.W.T., have taken definite steps towards establishing a municipal lighting and power plant. The various companies supplying boilers, engines, etc., have sent in their tenders for the requirements of the town. The tenders were opened and the climax of a strenuous meeting of the Council was reached in a decision to proceed with the construction of the plant. However, the tenders were found to be so complicated that it was impossible to reach an intelligent decision in regard to them. This is an old story and due to the haste in which such matters are often decided.

Municipal ownership has been the subject of much discussion, and as we go to press, we note the rather unfortunate predicament in which the Town of Berlin, Ont., finds itself, in regard to the municipal gas lighting plant. We must congratulate the Calgary Council for the wisdom shown in calling a reliable consulting engineer to advise them in their important decision as to a municipal plant. If there is one thing more than another that throws discredit on municipal ownership, and makes such plants unsuccessful, it is an error made when the plant is originally installed. The plant is often installed under the supervision of the town engineer, who is usually a civil engineer and not familiar with steam or electric engineering. He is not supposed to be posted in this branch of engineering and cannot be blamed if his efforts in this direction are not successful.

MOONLIGHT SCHEDULE FOR MAY.

Date.	Light.	Date.	Extinguish.	No. of Hours.
May 1	7 30	May 2	4 10	8 40
2	7 30	3	4 10	8 40
3	7 30	4	4 10	8 40
4	7 30	5	4 10	8 40
5	7 30	6	4 10	8 40
6	7 30	7	4 10	8 40
7	7 30	8	4 10	8 40
8	7 30	9	4 10	8 40
9	7 30	10	4 00	8 30
10	10 45	11	4 00	5 15
11	11 30	12	4 00	4 30
13	0 10	13	4 00	3 50
14	0 45	14	4 00	3 15
15	1 20	15	4 00	2 40
16	2 00	16	4 00	2 00
17	No Light	17	No Ligh	
18	" "	18	" "	
19	" "	19	" "	
20	7 50	20	10 40	2 50
21	7 50	21	11 40	3 50
22	7 50	23	0 30	4 40
23	7 50	24	1 10	5 20
24	7 50	25	1 50	6 00
25	7 50	26	2 20	6 30
26	8 00	27	2 50	6 50
27	8 00	28	3 15	7 15
28	8 00	29	3 40	7 40
29	8 00	30	3 30	7 30
30	8 00	31	3 30	7 30
31	8 00	June 1	3 30	7 30
			Total..........	172 45

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS, Imperial Building.

April 8th, 1905.

After reading the late Editorial on the enormous power lost by steam generation, one is quite prepared for the announcement on another page that the City of St. Thomas, Ont., have determined to try Oill ! !

The east end Bell Telephone exchange in this city is now complete and working by means of the Central Energy system. The Main exchange is now receiving attention and will be working Central Energy in a few months. This leaves only Westmount and Uptown; the former will no doubt be left with magneto ringers for some time to come ; but as Uptown is to have a new building, doubtless Central Energy will be installed there.

The small "Plumber and Electrician" gets in some fine work occasionally. One job noted lately showed brackets connected to gas pipes with hickeys (only), no joints soldered, fixture redone with aluminum bronze, the insulating joint being treated to coat of it, and bridging same—the fixture wiring itself being grounded ; two wires of a three way switch outlet coupled together and put in one side of an S.P. switch, ditto at other 3-way switch. This is a sample of competitive work in Montreal and the rabid desire for cheapness. Needless to say in above case the Montreal Light, Heat & Power Company refused to connect and the work had to be done over—not, however, by the plumber.

There is talk of opening and closing the locks, etc., at Lachine Canal by electricity. It is to be hoped the scheme will go through, as were any mariner asked the question, it is 10 to 1 he would state that the operation of Lachine canal is slower than any other from Lake Superior down. This should not be so at the final exit from inland to ocean navigation, and it is important, not only for Montreal, that electricity is to take the place of manual power.

The Trades and Labor Council were complaining to the Aldermen lately that the Montreal Street Railway did not build all their cars in Montreal as provided for in the franchise. True or not true, the fact remains that the very members of said organization are the principal complainants anent the scarcity of cars at 6 p. m. It looks very much as if the Council of Labor was trying to defeat the ends of their members.

Another brilliant scheme has been forwarded re. street railway fares in a letter to an evening newspaper, suggesting a zone system, or "penny per mile" scheme as worked in certain cities in Great Britain. If the correspondent uses the cars at the rush hours he would see that to do such would need a conductor of the strength of steel and speed of an express, not to mention a memory par excellence. Our conductors are only human beings and have their work cut out for them on cold nights giving transfers, which by the way are not given in the cities so glibly pointed out by the correspondent.

The discussion now going on in the English technical press re "Patrol busses vs. Electric Tramways" calls to mind the gasolene bus or automobile which last summer used to convey passengers from Victoria square via Victoria Bridge to St. Lamberts. It was as much as a lady's gloves or blouse (be they light in color) were worth to ride in it, and as the motor was always started up a minute or two before the journey, the effect of sitting in a cloud of gasoline smoke and heat can more readily be imagined than described. If the said South Shore Automobile Company want to make it popular, the sooner they re-arrange for electric propulsion the better. As it is practically a "level" trip, there should be no difficulty, and "charging" current could be arranged for at both ends if necessary from the A. C. mains of the Montreal L. H. & P. Company, by means of suitable motor and generator. The present arrangement can only be classed as a "horror".

Dealers in electrical supplies in Canada are in a more fortunate position than their confreres in the United States. There are many lines not yet manufactured in Canada which per force must be imported. When U. S. "trusts" get their prices too high for convenience then we can turn (often with profit) to Great Britain. Some American representatives are beginning to find that between the other side of the water and home manufactures their old happy hunting grounds here are getting played out.

The Montreal Light, Heat & Power Company have closed a contract for five years for lighting the harbor of Montreal. The lamps to be used are Western Electric series alternating arcs. They have also closed a contract with the Laprairie Brick Company to supply 1,000 h. p. The Laprairie Company are to build the line themselves, under the supervision of the Montreal Light, Heat & Power Company. This line will be tapped to the Chambly transmission line and will extend seven miles.

The Montreal Light, Heat & Power Company are supplying the Ogilvie Mills Company between 800 and 1,000 h. p. temporarily while the water is out of the canal.

CANADIAN GENERAL ELECTRIC COMPANY.

The annual meeting of the Canadian General Electric Company was held last month, at which it was decided to increase the capital stock of the company by $900,000.

The company's profits for the past year were shown to amount to $582,519.60, as against $512,210 for 1904. After paying dividends amounting in the aggregate to $392,763.52, the sum of $113,612.37 was written off for depreciation, $75,000 transferred to reserve, and $1,143.71 added to the credit of profit and loss account, which now stands at $81,913.42. Considerable sums were expended in creating the locomotive department, which is now on a normal manufacturing basis.

It was reported that from January 1 to March 5 contracts to the amount of $1,007,000 had been closed by the electrical department, and $381,000 by the foundry department. These amounts, added to the total unfinished business carried forward from 1904, make a gross total of $4,118,000.

THE CANADIAN WESTINGHOUSE COMPANY.

The first annual meeting of the shareholders of the Canadian Westinghouse Company, Limited, was held at Hamilton on March 28. The report submitted showed that during the fourteen months of its existence, and with only a portion of its plant in operation, the company earned $160,596, or over 6 per cent. upon the paid-up capital stock. The present year began with orders on hand of approximately $560,000. The assets of the company are placed at $2,926,724.43.

The directors' report stated that the new manufacturing plant was practically completed, and in a short time the manufacture of electrical apparatus would be commenced.

The following were elected directors:—George Westinghouse, H. H. Westinghouse, Hon. J. M. Gibson, Frank H. Taylor, Warren Y. Soper, L. A. Osborne, T. Ahearn, George C. Smith, C. F. Sise, Paul J. Myler.

At a subsequent meeting of the directors, Mr. George Westinghouse was elected president: Mr. H. H. Westinghouse, first vice-president ; Mr. Frank H. Taylor, second vice-president ; Mr. Paul J. Myler, third vice-president and treasurer ; and Mr. John H. Kerr, secretary.

PERSONAL.

Mr. A. W. Brown has been appointed chief engineer at the electric light plant, Brockville, Ont.

Mr. E. H. Keating, formerly manager for the Toronto Railway Company, has been appointed manager and engineer of electric railway, power and light franchises owned by the Mackenzie & Mann syndicate at Monterey, Mexico.

Prof. L. A. Herdt, Professor of Electrical Engineering at McGill University, Montreal, has received from the Government of France the honorary title of Officier d'Academie, a distinction granted for services rendered in the field of art, science, and literature.

Mr. F. A. Huntress, who was for several years manager of the Halifax Electric Tramway Company and more recently has been general manager of the Worcester Consolidated Street Railway Company in Massachusetts, has just been appointed manager of the Rio Janeiro Light & Power Company, in which American and Canadian capitalists are largely interested. The many friends of Mr. Huntress will be pleased to learn of his appointment, which we understand carries with it a very substantial remuneration.

Following the appointment of Mr. R. J. Fleming as general manager of the Toronto Street Railway, comes the announce- of several changes among the superintendents of departments. Mr. Ewan Mackenzie, brother of President William Mackenzie, who has been assistant superintendent for several years, has tendered his resignation and will for the immediate future be engaged in the construction of the Metropolitan extension from Newmarket to Jackson's Point. Mr. Alex. Smith, who has been 21 years in the street railway service, and latterly as electrical mechanical superintendent, has resigned and is superseded by Mr. J. Donnelly, of Cincinnati. Mr. W. H. Moore, who has been assistant to President Mackenzie, will take no further par in the management, having been appointed secretary of the James Bay Railway and virtually managing director of the York Radial Railways. Mr. Edwin Whittaker, inspector, will also leave the company, having received an important appointment from Mr. C. E. A. Carr, manager of the London street railway. Mr. James H. Wallace, another inspector, has obtained a more lucrative position under Mr. E. H. Keating, resident manager of the Mackenzie & Mann electric railway interests in Monterey, Mexico.

SPARKS.

The Packard Electric Company, St. Catharines, Ont., have established a factory for the manufacture of automobiles.

The City Council of Montreal have received tenders for a waterworks pump and are now considering whether to purchase a steam pump at a cost of $53,000 or an electric pump at a cost of $16,000. Both pumps are to be capable of pumping 12,000,000 gallons every twenty-four hours.

A dispatch from New York, dated March 21, states that the Westinghouse Electric & Manufacturing Company are preparing plans for the construction of a huge electrical power plant at Grand Falls N. B., by a syndicate of New York, New England and Canadian capitalists, comprising the Electro Manganese Company, Burton E. Kingman, New York, Fred Sayles, Providence, and others.

American and Canadian capitalists have organized the Rio de Janerio Tramway, Light & Power Company, with a capital of $25,000,000. The objects of the company are to develop a large water power near Rio de Janerio and to transmit electric c rent to that city for electric light and power purposes. The pı noters include Sir William Van Horne, of Montreal; Willia Mackenzie, E. R. Wood and Z. A. Lash, of Toronto, and F. S. Pearson, consulting engineer, of New York.

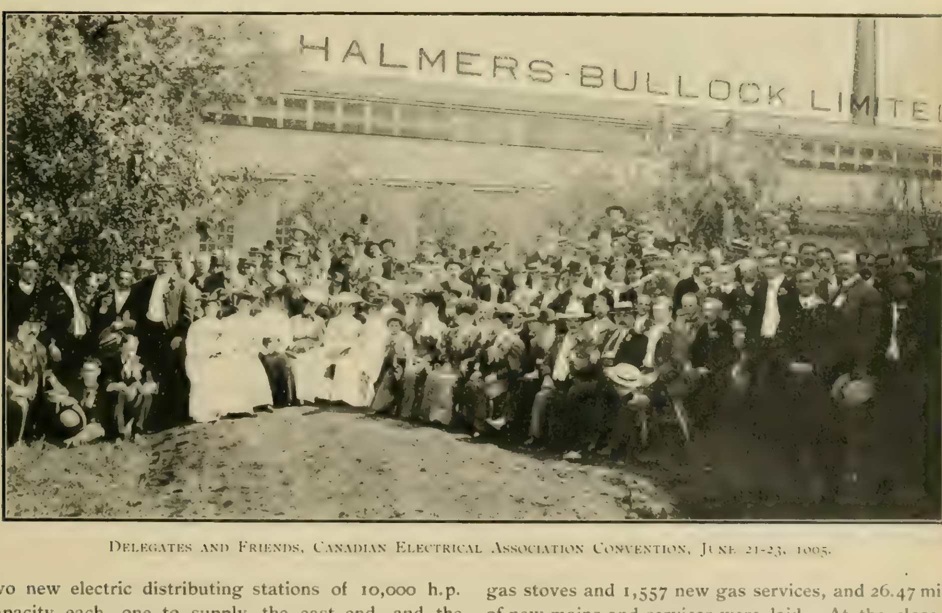
CANADIAN ELECTRICAL NEWS AND ENGINEERING JOURNAL

Vol. XV. JULY, 1905 No. 7.

ANNUAL REPORT OF LIGHT AND POWER COMPANY.

The fourth annual report of the Montreal Light, Heat and Power Company, recently submitted, showed that the gross revenue for the year amounted to $2,901,-264,67, and the net profits, after providing for fixed charges, interest, etc., to $1,128,789.05, being an increase over the previous year of $311,818,17 gross, and $244,775,20 net. The report says:

There are now under construction at the present time



Delegates and Friends, Canadian Electrical Association Convention, June 21-23, 1905.

two new electric distributing stations of 10,000 h.p. capacity each, one to supply the east end and the other the north end of the city. Both of these stations will be absolutely fireproof, and the electrical apparatus installed in same is the best and most modern that can be secured.

Your directors acquired by purchase the Provincial Light, Heat & Power Company, which controls, for the province of Quebec, the St. Lawrence Power Company, Limited, and owns the rights to all the surplus water of the Soulanges canal, and it is the intention to utilize the power from this source as soon as conditions warrant same.

During the year your directors entered into a 25-year contract with the Montreal Street Railway Company for an additional 7,000 h.p. of electric current, 4,000 h.p. of which is to be supplied by the 1st of July next, and the balance as the railway company may require same.

The extent of the increase in the company's business will be realized when it is noted that during the year 463 electric meters were installed, and 936 electric customers, representing 24,842 incandescent and 86 street arc lamps, and 53 motors, equivalent to 4,793 h.p., were added to the company's circuits. There were also installed during the year 4,390 gas meters, 2,304 gas stoves and 1,557 new gas services, and 26.47 miles of new mains and services were laid. At the close of the year there were connected to the service over 55,-000 gas and electric meters, and the prospects for additional business for the coming year are most favorable.

ELECTRIC SMELTING OF ORE.

It is stated that the Dominion Government have appropriated $15,000 for the purpose of making experiments with the electric process of smelting ores and manufacturing steel. The experiments will take place at Sault Ste. Marie and the Consolidated Lake Superior Power Company will furnish the necessary building and dynamos. The proposed erection of an experimental plant is doubtless the outcome of the investigations of the Commission headed by Dr. Haanel, Superintendent of Mines, which was sent to Europe last year.

C. E. A. CONVENTION NOTES.

The local committee earned the gratitude of everyone present for the splendid arrangements made for the convention.

Allis-Chalmers-Bullock, Limited, were again prominent by their daily register, of which there were four issues. The identity of any person could be ascertained by comparing the number on the white button worn with the register.

Free transportation was furnished to delegates by the Montreal Street Railway Company over the city lines and those of the Park and Island Railway. Each person was furnished with a book of fifty tickets, which was found to be a most convenient arrangement. The ticket is reproduced below:

MONTREAL STREET RAILWAY AND
MONTREAL PARK AND ISLAND RAILWAY
TO MEMBERS AND FRIENDS OF THE
Canadian Electrical Convention
GOOD FOR WEEK
COMMENCING JUNE 19 AND
ENDING JUNE 24, 1905
PRESIDENT

Thursday afternoon at the Allis-Chalmers-Bullock works was a very pleasant time. Special cars carried the party to Lachine, where the company extended hospitality in the shape of a very appetizing luncheon. A large marquee had been erected on the lawn outside the general offices of the company, and here over two hundred sat down to tastefully arranged tables. The president, Mr. K. B. Thornton, expressed the satisfaction of the association in accepting the hospitality of the company, to which Mr. George Bullock, president, and Mr. H. H. Henshaw, the general manager, replied in appropriate terms.

Mr. R. B. Hamilton, of the Packard Company, drove to the Bullock works an automobile party consisting of Messrs. A. L. Doremus, New York, Sheldon Cary, Cleveland, A. P. Doddridge, Quebec, Louis W. Pratt, Brantford, R. S. Kelsch, E. Irving, J. P. Kearney and George C. Rough.

The delegates were greatly interested in the sub-station of the Shawinigan Water and Power Company at Maisonneuve. In this terminal station there are one 8,000 h.p. frequency changer, five 1,200 h.p. frequency changers, two 900 k. w. 3-phase transformers, and two 800 k.w. rotary converters, all installed by Allis-Chalmers-Bullock, Limited. The 8,000 h.p. frequency changer was carefully inspected by the visitors, for it is not only the largest frequency changer ever built, but is composed of the largest alternating current generator in operation at the present time, viz., 5,750 k.w., and the largest electric motor ever built, viz., 8,000 h.p.

The Long Distance Hylo and Wynking Signs shown by the Packard Electric Company at the Convention represent opposite extremes; the one is a device for the lazy man, the other is intended for the hustler.

One of the novel features of the Convention was the "Wynking" signs used by the Packard Electric Company to inform everyone of the location of the Packard Headquarters in Room No. 30, Windsor Hotel. These signs consisted of circular frames studded with incandescent lamps which automatically flashed about once a second, and holding attractive cards announcing the location of headquarters for

"PACKARD LAMPS"
"PACKARD TYPE "G" METERS"
"PACKARD TYPE "R" TRANSFORMERS"
"JANDUS GOLD MEDAL ARC LAMPS"
"CROCKER-WHEELER APPARATUS"

These signs were hung in conspicuous places about the rotunda and corridors, and continually attracted a great deal of attention by their novelty. In Room No. 30 the Packard Company made a very interesting display of some of their newest features in transformer and meter design and manufacture; there were coils and sections of transformer coils showing the perfection of insulation obtained by the vacuum process with a compound of high insulating quality insoluble in oil. Specimens of the new moulded mica insulation recently developed by the Company for their Type "R" transformer were also examined with great interest by the many visitors. A new type of switchboard transformer was also exhibited, together with a switchboard type "G" recording wattmeter with glass cover. On a frame near by were Jandus multiple and series alternating arc lamps, and Mr. Sheldon Cary, of the Jandus Electric Company, Cleveland, who was present at the Convention, was kept busy in explaining their many good features to those interested in arc lamps.

Mr. A. L. Doremus, vice-president of the Crocker-Wheeler Company, for whom the Packard Electric Company are handling the sale of direct and alternating current apparatus in Canada, was also present. The Packard Electric Company itself was represented by Messrs. R. B. Hamilton, managing-director, George C. Rough, manager sales department, and J. Warren, acting manager eastern office.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., had a neat and attractive exhibit of electrical apparatus and appliances. Their headquarters were in Room No. 4 of the Hotel Windsor. Distributed at various places in the hotel were reproductions of the company's trade mark formed by electric light combinations. The company had on exhibition a line of their induction motors, direct current motors, OD transformers, series and multiple AC arc lamps, meters, lightning arresters, fuse blocks, portable testing instruments, etc. Distribution was made of a complete line of the company's literature illustrating and describing their products. A striking souvenir folder, prepared for the occasion, was given out to all the attendants at the convention.

A number of souvenirs were distributed at the Convention. Mr. E. Irving, manager of the Sunbeam Incandescent Lamp Company of Canada, handed to each person a purse with a combination lock, having on one side the inscription, "You can save money by using Sunbeam Lamps." Mr. Irving will be pleased to send one of these purses to any member of the Association who did not attend the Convention.

Messrs. J. A. Dawson & Company, 743 Craig street, Montreal, distributed a neat card counter, which served to remind the recipient that they are always in a position to supply railway, electrical and mill supplies.

Conduits Company, Limited, successors to the Richmondt Conduit and Manufacturing Company, Toronto, presented the delegates with a useful souvenir in the form of a match safe, the front of which contained the name of the company and of their well-known products, "Galvaduct" and "Loricated" conduits for interior construction. On the reverse side is a useful table of decimal equivalents, an invaluable aid to the electrician.

The Sayer Electric Company, Montreal, distributed a brush bearing the inscription, "The Sayer Electric Company, Montreal, Canada—Everything Electrical." Souvenirs were also distributed by the American Circular Loom Company, D. Sleeth, Montreal, and others.

BOILER INSPECTION IN MONTREAL.

Boiler Inspector Champagne, of Montreal, has recently made his report on the operations of his department last year, in which he deals briefly with the smoke nuisance. Upon this subject the report declares that towards the end of last year there were fewer complaints about smoke, owing to the increasing number of manufacturers who are doing all that is possible to decrease the nuisance.

The visits of inspection alone averaged five a day, the total being 1,541. There were besides 203 special visits and 787 hydraulic tests. From these inspections and tests 11 boilers were condemned as unsafe, and 133 found to be imperfect in construction. The orders of the department were evidently carried out as regards safety, as no accidents are reported from this source.

During the year the licenses issued by the department were 548, and 97 other applications were rejected.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS.

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. NO 1.—Just as our June issue was being mailed to subscribers, a communication reached this office, which read as follows: "I have never attended a Convention of the Electrical Association, and would like to know if you think it would be worth my while to go to Montreal? I don't think the above question really belongs to your 'Question and Answer Department', and if not you needn't bother with it. However, if you can advise me some other way, I will be very much obliged."

The "Question and Answer Department" of this paper was formed with the idea of bringing the CANADIAN ELECTRICAL NEWS into close personal touch with its many subscribers, and in this it has been particularly successful. While the object of the department was to deal with technical questions, we have not overlooked the primary intention, namely, to be of real use to our numerous friends. Therefore on receipt of the above letter, we immediately replied as follows:—

"Your letter reached us just too late for insertion in our June number, and we are therefore answering you direct. While the 'Question and Answer Department' is supposed to deal with technical problems only, we are only too glad to give information on other subjects which will be of value or assistance to our subscribers.

"From time to time it has been said that as all the papers and proceedings of the Convention are published in pamphlet form, shortly after the Association adjourns, it was hardly worth while for a man to go to the expense and possible inconvenience of attending a Convention in person. This, to say the least, is a very narrow minded policy. If one sit down and think carefully over the science of electricity, it seems really as if the impossible had been accomplished. Here we are dealing with a thing whose real nature we know nothing of, but in spite of this apparently insurmountable difficulty, the science has made, within an incredibly short time, the most enormous strides. Each year sees some further advance, some new improvement, or some invention which changes materially some essential feature of the art. Twenty years ago it was said that all that could be known of electricity was then known, and that the science had reached a dead wall and was at a standstill. Years later the same remark was made, but the boldness of the first sweeping assertion was lacking. Nowadays, we look upon ourselves as having accomplished wonders, but instead of being pessimistic about the future, we are exceedingly sanguine, and while we do not know just what is going to happen next, we rather expect that very shortly some momentous change will take place. Considering the fact,, before stated, that we do not know with what we are dealing, we must look for some peculiar condition to explain our progress. It can be given in a nutshell. Among the members of the electrical profession, there always has been the fullest possible co-operation; this co-operation exists to-day, and always will exist. That is the whole secret.

"Therefore, our answer to your question is, Go to Montreal, and co-operate with your fellow members. Let everyone do this, and he makes himself an appreciable unit in the advancement of the science.

"Incidentally we hope that you will enjoy yourself, and we think you will consider that the trip was very much worth while."

The above was written before the Convention, and we think that the results have more than justified the advice given to our correspondent. We saw him in Montreal and he told us frankly that our reasoning was sound, and that next year would see him at the Convention in Niagara Falls, and all following years at such points as were selected. He has seen an example of co-operation, and he thoroughly appreciates the necessity.

The above, as before mentioned, is really outside the scope of this department, but we have made an exception in this case, and we stand quite ready to do so again where circumstances permit us to be of real value to our readers.

QUES. NO. 2. — On my boiler here I am carrying a steam pressure of 80 pounds, and want to know if it would be more economical to increase the pressure to 100 pounds. Will it take more coal to make steam at 100 pounds, and how will the steam consumption of the engine be affected?

ANS.—You will certainly get a greater economy by increasing the steam presssure, but before doing so, we would advise you to make sure that your boiler is able to carry the increased pressure, and that your steam piping is in the required condition, and that the engine is capable of standing the increased strains which will be put upon it. So far as the boiler is concerned, the company which carries your boiler insurance will advise on this point. Regarding the engine, the manufacturer will no doubt give you the desired information upon request. Considering the boiler end only, the higher the steam pressure, the greater the capacity of the boiler, and the more economical its operation. To evaporate 500 pounds of water per hour at a pressure of 100 pounds, will of course take more coal than if the evaporation takes place at 80 pounds. Here the increase of pressure is 25%, but the increase in coal will be but little over 1/2 of 1%. This is the theorectical increase, and is based on a feed water temperature of 125° F., the factors of evaporation at this temperature being for 80 pounds 1.1262, and 100 pounds 1.1306. From the above you will see that with a very little increase in coal, the pressure can be raised considerably. With your engine, if the load and speed be constant, then to do the work a definite mean effective pressure will be required on the piston. This pressure will be constant, irrespective of change of initial or boiler pressure. If with an initial pressure of 80 pounds, you get a mean effective prsssure of 30 pounds, the engine cutting off at one-quarter stroke, then when the initial is increased to 100 pounds, the cut off will have to be shortened to give the same effective pressure in the cylinder. During the time when the valve of the engine is open, the steam pressure in the cyclinder is the same as in the boiler, less the loss which takes place in the piping. If the engine cut off at one quarter stroke, then the steam at boiler pressure will fill the ports of the engine and one quarter of the cylinder, per stroke. With an increased initial pressure, the cut off will be shortened as before mentioned, and consequently the combined area of ports and the less than one-quarter of the cylinder will be filled with steam at the increased pressure. Thus, with increased pressure, the quantity or volume of steam used will be less, but this can be calculated only if the area of the ports, clearance, etc., be known. If we assume that the area filled with steam at 100 pounds be 10 less than that when 80 pounds is used, then the engine with the higher pressure will use 10% less steam. However, the coal consumption has been increased ½ of 1%, and therefore, by raising the pressure from 80 to 100 pounds the coal consumption will be reduced 9½%. This is the approximate theoretical reduction of course, taking into consideration the conditions named above. In practice this full result may not be obtained, but certainly, if the apparatus will stand it, the increase in pressure is worth while.

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Advertising rates sent promptly on application. Orders for advertising should reach the office of publication not later than the 1st day of the month immediately preceding date of issue. Changes in advertisements will be made whenever desired, without cost to the advertiser, but to insure proper compliance with the instructions of the advertiser, requests for change should reach the office as early as the 26th day of the month **for the succeeding month's issue.**

SUBSCRIPTIONS.

The ELECTRICAL NEWS will be mailed to subscribers in Canada, or the United States, post free, for $1.00 per annum, 50 cents for six months. The price of subscription should be remitted by currency, registered letter, or postal order payable to the C. H. Mortimer Publishing Company of Toronto, Limited. Please do not send cheques on local banks unless 25 cents is added for cost of discount. Money sent in unregistered letters will be at senders' risk. Subscriptions from foreign countries embraced in the General Postal Union $1.50 per annum. Subscriptions are payable in advance. The paper will be discontinued at expiration of term paid for if so stipulated by the subscriber, but where no such understanding exists, will be continued until instructions to discontinue are received and all arrearages paid.

Subscribers may have the mailing address changed as often as desired. When ordering change, always give the old as well as the new address.

Subscribers are requested to promptly notify the publishers of failure or delay in delivery of the paper.

EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Canadian Electrical Association. The Fifteenth Convention of this Association held in Montreal last month must be considered to have been in many important particulars the best meeting in the history of the organization. The register shows the attendance to have numbered 326. Making a fair allowance for visitors not on the membership list, this record shows a gain in attendance of one hundred above any previous Convention. It is also gratifying to note that the attentance included persons residing as far east as Halifax and west to Sudbury, Port Arthur and Fort William. This, with the invitation extended by the Halifax Board of Trade asking that a Convention be held in the Eastern Provinces, and the statement of a Winnipeg member that next year an invitation would probably be presented for a Convention in the west, may be taken as an indication of a widening interest in the Association.

The Montreal meeting was essentially a business Convention. There were more papers than usual on the programme, and the subjects were of a character to especially interest the owners and operators of central stations, of whom there were present a larger number than usual. Not only were all the papers interesting and highly instructive in themselves, but they evoked discussions which were probably quite as valuable. It is safe to say that it would have paid the owners of electric light and power stations of even average capacity to have sent a representative to this Convention. The information to be gained from the reading and discussion of the papers, as well as from mingling and comparing notes with many others in the same line of business, would have amply repaid the cost of the trip. It is learned that some central station superintendents were absent from this meeting because the companies with which they are connected were not willing to pay their expenses, and they did not feel that they could afford to pay them themselves. This is undoubtedly mistaken policy on the part of the companies and one which we hope to see changed as regards the future. The rooms of the Canadian Society of Civil Engineers, kindly placed at the disposal of the Association, proved an ideal place for the business sessions, and resulted in improved attendance and closer attention by the members to the proceedings. With the exception of one afternoon and evening, the time of the Convention was entirley devoted to business. This policy of subordinating the entertainment features to the business for which the Conventions are called together, is generally recognized as the one which should prevail for the future and best promote the welfare of the Association.

In view of the interest attaching to the extensive power development works at Niagara Falls, which works will, a year hence, be well advanced towards completion, it was the wish of the majority of the members that the next Convention be held at that point. It is felt, however, that, if possible, in the near future the influence of the Association should be extended by the holding of Conventions in the Maritime Provinces and also in Western Canada. The Association has selected a strong Executive under whose managment its affairs during the coming year are certain to be wisely managed.

Canadian Electrical Association

Proceedings of the Fifteenth Annual Convention

THE Fifteenth Annual Convention of the Canadian Electrical Association was held in the rooms of the Canadian Society of Civil Engineers, in the City of Montreal, on Wednesday, Thursday and Friday, the 21st, 22nd and 23rd of June, 1905.

At 11 o'clock a.m. on Wednesday the President, Mr. K. B. Thornton, of Montreal, took the chair, and called the Convention to order.

The following persons were registered as being in attendance :

A

C. H. Abbott, St. John, N.B., R.E.T. Pringle Co.
W. P. Ambos, New York, Osborne Flexible Conduit Co.
Thos. A. Aiton, New York, Aiton Machine Co.
W. M. Andrew, Montreal, Canadian Westinghouse Co.
M. K. Adams, Montreal, Crescent Electric Co.

B

R. G. Black, Toronto, Supt. Toronto Electric Light Co.
H. D. Bayne, Montreal, Canadian Westinghouse Co.
H. A. Burson, Montreal, Allis-Chalmers-Bullock, Ltd.
W. Bradshaw, Pittsburg, Westinghouse Electric & Manufacturing Co.
C. W. Bongard, Toronto, C. W. Bongard & Co.
E. M. Breed, Montreal, Canadian Westinghouse Co.
R. E. Brandeis, Montreal, G. M. West, Contractor.
Alex. Barrie, Montreal, The Wire & Cable Co.
George Bullock, Montreal, Allis-Chalmers-Bullock, Ltd.
T. H. Bibber, New York, American Circular Loom Co.
N. S. Braden, Hamilton, Canadian Westinghouse Co.
Wm. A. Bucke, Toronto, Canadian General Electric Co.
E. D. Brand, Berlin, Berlin Electric Co.
F. E. Barbour, Montreal, New York Central Railway.
D. E. Blair, Montreal Street Railway.
D. P. Burke, Ottawa & Hull Power & Mfg. Co.
Lewis Burran, Quebec, Quebec Railway, Light & Power Co.
T. Beecroft, Barrie, Ont., Barrie Electric Light Plant.
A. F. Byrd, Montreal Street Railway.
G. Boyer, Montreal Street Railway.
Acton Burrows, Toronto, "Railway and Shipping World."
W. D. Bird, Montreal, Montreal Light, Heat & Power Co.
F. Jno. Bell, Montreal, Canadian General Electric Co.
R. H. Balfour, Montreal Light, Heat & Power Co.
H. E. Blatch, Montreal, Canadian Westinghouse Co.
Fred Beck, New York, Westinghouse Co.
C. G. Buck, Montreal, J. A. Dawson & Co.
J. A. Burnett, Montreal Light, Heat & Power Co.
J. A. Burns, Montreal, Munderloh & Co.
E. J. Bengough, Toronto, "Canadian Engineer."
V. Boyd, Toronto, Canadian General Electric Co.
F. B. Brown, Montreal, Ross & Holgate.
H. G. Bower, New York.
Geo. A. Brebner, Schenectady, N.Y.
J. W. Blanchet, Montreal, St. Cesaire Hydraulic Co.
Geo. C. Burnham, Montreal, Allis-Chalmers-Bullock, Ltd.
Mr. Bastien, Montreal.

C

Alfred Collyer, Montreal, Allis-Chalmers-Bullock, Ltd
James J. Campbell, jr., Montreal, Canadian Westinghouse Co.
J. Cahill, "Montreal Herald."
Fred Chowen, Stratford, Stratford Gas & Electric Co.
Sheldon Cary, Cleveland, Ohio, Jandus Electric Co.
J. W. Campbell, Toronto, Canadian General Electric Co.
John Cochrane, Berlin, Ont., Berlin Electric Light Co.
H. J. Chapman, Montreal Street Railway.
T. W. Casey, Montreal Street Railway.
F. A. Chisholm, St. Johns, P.Q., St. Johns Electric Light Co.
E. Craig, Montreal.
Geo. S. Chester, Pittsburg, Pa., Westinghouse Electric & Manufacturing Co.
S. T. Calloway, Montreal, Locomotive & Machine Co.
E. R. Carrington, Montreal, Shiel Detective Co.
H. M. Campbell, Montreal.
E. Camp, Montreal, W. J. O'Leary Co.
Jno. M. Cox, Montreal Light, Heat & Power Co.
S. B. Condit, jr., Boston, Mass., Conduits Co., Ltd.
L. A. Casgrain, mgr. Chicoutimi Electric Co.
A. J. Carroll, Montreal, E. F. Phillips Electrical Works.
C. W. Cliff, Montreal, MacLean Publishing Co.
Norman M. Campbell, Montreal, Canadian Rand Drill Co.
N. Curry, Rhodes, Curry & Co., Amherst, N.S.

D

A. A. Dion, Ottawa, Supt. Ottawa Electric Co.
W. F. Dean, Montreal, Canadian General Electric Co.
W. A. Duff, Montreal, Canadian Westinghouse Co.
H. B. Douglas, Montreal, Canadian White Co.
J. M. Deagle, Cataract, Ont., Cataract Electric Co.
G. R. Duncan, Three Rivers, Que., Montreal Pipe & Foundry Co.
P. Dube, Montreal Street Railway Co.
J. Dick, Montreal Street Railway Co.
J. A. Dawson, Montreal, J. A. Dawson & Co.
L. Denis, Quebec, Jacques Cartier Electric Co.
H. K. Dutcher, Montreal, Allis-Chalmers-Bullock, Ltd.
A. P. Doddridge, Quebec Railway, Light & Power Co.
P. R. Diamond, Montreal, Canadian Bronze Co.
A. N. Dufresne, St. Cesaire, Que., St. Cesaire Hydraulic Co.
A. H. Chas. Dalley, Chicago, Westinghouse Machine Co.
A. L. Doremus, Ampere, N.J., Crocker-Wheeler Co.
H. Stansfield Dodd, Toronto, Dodd Electric Co.
T. F. Dryden, Toronto, Canadian Westinghouse Co.
R. J. Dunlop, Toronto, Canadian Westinghouse Co.

E

E. A. Evans, Quebec Railway, Light & Power Co.
A. Esling, Toronto, R. E. T. Pringle Co.
E. D. Edmundson, Oshawa.
J. Elson, Montreal "Gazette."

F

H. J. Fuller, Montreal, Canadian Fairbanks Co.
E. R. Frost, Quebec, Jacques Cartier Electric Co.
Bert Fogarty, Montreal, Fogarty Bros.
J. A. Fletcher, Montreal, R. E. T. Pringle Co.
Thomas R. Fulton, Montreal, Eugene Phillips Electrical Works.
V. Falconer, Montreal, Gunn, Richards & Co.
Chas. L. Farrar, Lakefield, Ont., Lakefield Light & Power Co.
F. Wilson Fairman, Montreal, Dominion Wire Co.
H. O. Fisk, Peterboro Light & Power Co.
A. S. Forman, Montreal, J. Forman.
J. M. R. Fairbairn, Montreal, Canadian Pacific Railway.

G

P. G. Gossler, New York, J. G. White & Co.
Nelson Grayburn, Montreal Street Railway.
W. C. Girard, Farnham, Que., Farnham Electric Co.
A. Gaboury, Montreal Street Railway.
H. Grandbois, St. Casimir, Que.
W. S. Gardner, Montreal.
A. J. Gorrie, Montreal, Great Northern Railway.
M. L. Gordon, New York.
J. W. Gilmore, Montreal, Eugene F. Phillips Electrical Works.
W. A. Gatrison, Toronto, Chapman Ball Bearing Co.
J. D. Gillies, Montreal, Montreal Light, Heat & Power Co.

H

Gordon Henderson, Hamilton, Supt. Cataract Power Co.
Chas. B. Hunt, London, Mgr. London Electric Co.
C. W. Henderson, Montreal, Canadian Westinghouse Co.
H. H. Henshaw, Montreal, Allis-Chalmers-Bullock, Ltd.
Thomas Hilliard, Ottawa, Canadian General Electric Co.
E. P. Hannam, Toronto, Canada Foundry Co.
J. Herbert Hall, Toronto, Conduits Co., Limited.
Ormond Higman, Ottawa, Chief Elec. Eng. Inland Revenue Dept.
H. C. Hitch, Montreal, Canadian White Co.
H. O. Hart, Hamilton, Canadian Westinghouse Co.
P. H. Hover, New York, New York Insulated Wire Co.
M. C. Hall, Berlin, Berlin Electric Co.
J. D. Hathaway, Montreal, Wire & Cable Co.
J. C. Hyde, Montreal.
R. B. Hamilton, St. Catharines, Ont., Packard Electric Co.
R. M. Hannaford, Montreal Street Railway.
S. Humphries, Montreal, Electric Repair Co.
L. A. Herdt, Montreal, McGill University.
D. H. Hudson, Winnipeg, Hudson Electrical Supply Co.
E. H. Hughes, Montreal, H. W. Johns-Mansville Co.
Robert W. Hogg, Montreal, Canadian General Electric Co.
J. S. Hartman, Montreal, Canada Car Co.
H. A. Hamilton, Pittsburg, Pa., Westinghouse Electric & Mfg. Co.
A. R. Henry, Montreal, Ross & Holgate.
J. E. Hutchison, Ottawa, Electric Railway Co.
F. Hatch, Whitby, Ont., Martin Manufacturing Co.
L. A. Howland, St. John's, Nfld., Reid Newfoundland Co.
A. P. Horner, Montreal, Canadian General Electric Co.
W. T. Hall, Montreal, Grand Trunk Railway.
L. B. Hastings, Pittsfield, Mass., Stanley Electric Mfg. Co.

I

E. Irving, Toronto, Sunbeam Incandescent Lamp Co.
W. G. Irwin, Toronto, "Canadian Manufacturer."

J

Wallace C. Johnson, C.E., Montreal, Shawinigan Water and Power Co.
C. W. Johnson, Montreal, Allis-Chalmers-Bullock, Ltd.
Phelps Johnson, Montreal, Dominion Bridge Co.
E. J. Jenkins, Toronto, Canadian General Electric Co.
F. S. Jones, Fort William, Ont., Supt. Electric Light and Telephone Co.
Chas. F. R. Jones, Montreal, Wire & Cable Co.
James Johnston, Ottawa, Public Works Department.
R. F. Jones, Montreal, Bell Telephone Co.
G. R. Jonghins, Moncton, N.B., Intercolonial Railway.

K

J. A. Kammerer, Hamilton, Director Cataract Power Co.
R. S. Kelsch, Montreal, Consulting Engineer.
T. F. Kenney, Montreal, Allis-Chalmers-Bullock Co., Ltd.
F. S. Keith, Toronto, "Canadian Machinery."
W. P. Kearney, Montreal, Packard Electric Co.
Henry C. Kelley, New York, New York Turbine Engineering Co.
C. G. Keyes, Ottawa, Ottawa Electric Co.
Floye Kedledge, New York, N.Y.
C. A. King, East Angus, Que., Royal Pulp and Paper Mills Co.

L

J. D. Lachapelle, Montreal, Richelieu and Ontario Navigation Co.
A. B. Lambe, Toronto, Canadian General Electric Co.
F. H. Leonard, Jr., Montreal, Electric Engineering Co.
H. R. Lockhart, Montreal Street Railway.
T. D. Lonergan, Quebec, Chateau Frontenac.
D. Logan, Montreal, John Forman.
E. S. Leetham, Buckingham, Que., The Lievre Valley Power, Traction and Manufacturing Co.
L. A. Lapointe, Montreal.
C. Lesperance, Feversham Electric Light Co.
H. Laporte, Montreal, Mayor.

M

Fred A. McLay, Montreal, G. T. Pringle & Son.
Newton MacTavish, Toronto, "Globe."
John S. MacLean, Montreal, Allis-Chalmers-Bullock, Ltd.
R. T. MacKeen, Toronto, Canadian General Electric Co.
D. McQuade, Montreal, Electric Engineering Co.
W. L. Macfarlane, Cornwall, Ont., St. Lawrence Power Co.
Thomas H. McCauley, Port Arthur, Ont., Gen. Supt. Municipal Plant, Corporation of Port Arthur.
D. MacDonald, Montreal Street Railway.
Dermot McEvoy, Montreal, Canadian Rubber Co.
Allister Maclean, Montreal, Robb Engineering Co.
Albert Maclaren, Buckingham, Que., James Maclaren Co.
John A. Maclaren, Ottawa.
H. McPhee, Montreal, Fred Thomson Co.
Wm. McCaffrey, Toronto, Canadian General Electric Co.
B. G. McBurney, Winnipeg, Canadian General Electric Co.
N. G. MacLeod, Toronto, Beardmore Belting Co.
C. H. Mortimer, Toronto, "Canadian Electrical News."
John Murphy, Ottawa Electric Co.
H. A. Moore, Toronto, Allis-Chalmers-Bullock, Ltd.
R. H. Martindale, Sudbury Corporation.
D. C. Meloon, Montreal, John Forman.
Paul J. Myler, Hamilton, Canadian Westinghouse Co.
Robt. J. Mercer, Montreal, Canadian Iron & Foundry Co.
G. H. Muir, Montreal, "Canadian Electrical News."
J. A. Mann, Montreal.
T. J. Mullen, Montreal, Allis-Chalmers-Bullock, Ltd.
F. Marchand, St. Johns, Que., St. Cesaire Hydraulic Co.
J. M. Mackie, Montreal, Laurie Engine Co.
Chas. Martin, Montreal.
C. H. Martin, Toronto.
A. Mosher, Montreal, "The Gazette."

N

M. Neilson, Montreal Street Railway.
Milton Ney, Bracebridge Electric Light & Power Co.
Thos. F. Nivin, Montreal, Otis Elevator Co.

O

Dr. R. B. Owens, Montreal, Professor of Electrical Engineering, McGill University.
W. J. O'Leary, Montreal, W. J. O'Leary & Co.
F. G. O'Grady, Montreal, Canadian Iron & Found'y Co.
Geo. H. Olney, Montreal, E. F. Phillips Elecrical Works.

P

R. E. T. Pringle, Montreal, The R. E. T. Pringle Co.
J. W. Purcell, Walkerville, Hiram Walker & Sons.
H. C. Philpot, Toronto, Canada Foundry Co.
J. W. Pilcher, Halifax, N.S., Canadian General Electric Co.
T. R. Price, Montreal, Sunbeam Incandescent Lamp Co.
G. Porteous, Montreal, Canadian White Co.
Alex. Pringle, Montreal.
W. J. Plews, Montreal.
F. J. Parsons, Montreal, McDonald & Wilson.
F. H. Pitcher, Montreal Water & Power Co.
H. B. Pope, Montreal Light, Heat & Power Co.
Chas. W. Price, New York, Electrical World.
Louis W. Pratt, Brantford Electric & Operating Co.

R

B. F. Reesor, Lindsay, manager Georgian Bay Power Co.
W. P. Roper, Montreal, Canadian General Electric Co.
George C. Rough, St. Catharines, Ont., Packard Electric Co.
F. Rose, Toronto, Canadian General Electric Co.
W. H. Reynolds, Montreal, Canadian General Electric Co.
P. D. Rutty, Montreal, Canadian White Co.
R. B. Reid, Toronto, Beardmore Leather Co.
W. G. Ross, Montreal Street Railway.
D. Robertson, Montreal Street Railway.
W. M. Reid, Montreal Street Railway.
B. Robinson, Montreal "Star".
J. M. Robertson, Montreal Light, Heat & Power Co.
Fletcher C. Ransom, New York, N.Y.
Thos. Rogers, Montreal, Great North-Western Telegraph Co.
L. Rubenstein, Montreal Light, Heat & Power Co.
E. A. Rhys-Roberts, Montreal, Dominion Bridge Co.
R. N. Robins, Sherbrooke, Que., Sherbrooke Power, Light & Heat Co.
Thos. T. Renton, Kingston, Ont., Campbell & Renton.
Robert A. Ross, Montreal, Ross & Holgate.
Lacasse Rosseau, Montreal, Canadian Electric Co.

S

A. B. Smith, Toronto, Great North-Western Telegraph Co.
C. F. Sise, Jr., Montreal, Bell Telephone Co.
E. F. Sise, Montreal, Wire and Cable Co.
George A. Stanley, Montreal, Canadian Westinghouse Co.
S. W. Smith, Montreal, Canadian Westinghouse Co.
Robert J. Smith, Perth, Canadian Electric and Water Power Co.
C. C. Starr, Halifax, N.S., Canadian Westinghouse Co.
R. W. Saxby, Corporation of Whitby Lighting Plant.
D. Sleeth, Montreal.
Arch. W. Smith, Toronto.
B. F. Selby, Toronto, Canadian General Electric Co.
C. S. Stokes, Montreal, Canadian Westinghouse Co.
Paul F. Sise, Montreal, Northern Electric Co.
H. H. Scott, Perth, Ont., Canadian Electric and Water Power Co.
C. W. Schiedel, Waterloo, Ont., Manager Waterloo Electric Light Co.
H. E. Smith, Montreal Street Railway.
J. Sangster, Power Glen, Ont., Hamilton Cataract Power, Light and Traction Co.
W. E. Simmons, Bracebridge, Ont., Bracebridge Light and Power Plant.
Irving Smith, Montreal, R. E. T. Pringle Co.
M. A. Sammett, Montreal Light, Heat and Power Co.
W. B. Shaw, Montreal Electric Co.
A. E. Sangster, St. Francis Hydraulic Co.
A. Sangster, Sherbrooke Power, Light and Heat Co.
H. G. Steele, Pittsburg, Pa., Pittsburg Transformer Co.
S. A. Stephens, Montreal, J. A. Dawson & Co.
A. E. Smaill, Montreal.
J. Norman Smith, Montreal, Ross & Holgate.
Geo. W. Sadler, Montreal, Sadler & Haworth.
E. A. Seath, Montreal, John Forman.
E. Steinler, New York.
Thos. Sadler, Fenelon Falls, Ont., Lindsay Light, Heat and Power Co.
E. D. Sifton, London, Ont., The Electrical Construction Co. of London, Ltd.

T

K. B. Thornton, Montreal Light, Heat & Power Co.
F. Thomson, Montreal, Fred Thomson & Co.
J. A. Thibodeau, Pembroke Electric Light Co.
David Trainor, New York, Canadian Copper Co.
H. G. Taylor, Montreal Street Railway Co.
L. Trudeau, Montreal Street Railway Co.
C. Thomson, Montreal, Fred Thomson & Co.
George Teroux, Montreal.
J. P. Thomson, Toronto, E. F. Phillips Electrical Works.

V

Frank P. Vaughan, St. John, N.B., Electrical Engineer.

W

A. A. Wright, M.P., Renfrew, Ont., Pres. Electric Light & Power Co.
J. J. Wright, Toronto, Manager Toronto Electric Light Co.
H. Woodcock, Montreal Street Railway.
R. M. Wilson, Montreal Light, Heat & Power Co.
W. V. Warren, Montreal, Allis-Chalmers-Bullock, Ltd.
George H. Weaver, Montreal, Dominion Foundry Supply Co.
A. M. Wickens, Toronto, Canadian Casualty & Boiler Ins. Co.
John H. Webber, Toronto, Montreal Rolling Mills.
W. Williams, Sarnia, Ont., Sarnia Gas & Electric Co.
Eugene Waugh, New York, General Chemical Co.
A. E. Wilson, Montreal, John Forman.
Philip M. Walder, Montreal, The R. E. T. Pringle Co.
G. M. Wight, Montreal, The R. E. T. Pringle Co.
H. W. Weller, Montreal, Babcock & Wilcox.
Joseph Westgate, Montreal.
J. Warren, Montreal, Packard Electric Co.
W. McLea Walbank, Vice-President Montreal Light, Heat & Power Co.
D. H. Wilson, Montreal, American Locomotive & Machine Co.
C. A. Waterous, Brantford, Ont., Waterous Engine Works.
E. F. Waterhouse, Montreal.
Jos. Wood, jr., N.S. Steel & Coal Co., New Glasgow and Sydney Mines, N.S.
W. A. Walker, Montreal, Phillips Electric Co.

Y

John J. Yorke, Montreal, Chief Engineer St. Lawrence Sugar Refining Co.
Louis Yorston, Montreal Light, Heat & Power Co.

Z

R. H. Zavitz, Toronto, Allis-Chalmers-Bullock, Ltd.

The President then delivered the annual address, as follows :—

PRESIDENT'S ADDRESS.

To the Members of the Canadian Electrical Association :

Gentlemen,—It is a matter of great pleasure to me to welcome you all at the opening of the Fifteenth Annual Convention of the Association.

It is several years since the Association last met here in Montreal, and during the interval there has been so great an increase in the development of the electrical industries that you will find it both interesting and instructive to note the various changes and the great advance that has been made.

The Executive of the Association have made every effort to ensure the success of this year's Convention by securing an excellent programme of papers, and in addition our "Question Box" Editor, Mr. Dion, has been indefatigable in collecting questions and answers to matters of timely interest to the members.

It is the object of our Association to advance the interest of the Electrical Engineering profession in Canada, and to promote the general efficiency of the work done. That the object of the Association may be attained, it is necessary that high standards should be adopted, and that the combined assistance of the individual members should be received.

It is a matter of general knowledge to those who have been connected with the Association work for any length of time, that the interest taken by a large majority of members is very disheartening, and this condition of affairs will continue indefinitely unless a determined effort is made to interest a larger proportion of the membership. It is therefore desirable that a special committee be appointed at this Convention to investigate and report what steps are necessary to increase the membership of the association, and to induce a larger number of the members to contribute to the papers and discussions and also to take a greater interest in the Association's welfare.

It is the opinion of the Executive that the benefits to be derived from the general intercourse of members at the Annual Conventions have, in many instances, been dissipated by too large a preponderance of the entertainment feature. On account of this it has been decided this year to abandon the usual banquet and to reduce the number of entertainments in order to confine our attention more to the transaction of Convention business.

The Association this year is fortunately able to meet under particularly favorable circumstances, and are indebted to the courtesy of the Canadian Society of Civil Engineers for the use of their handsome and comfortable rooms. Personally, I feel sure that this kind co-operation on their part will be mutually beneficial.

In considering the reports received from the various committees, it is unnecessary for me to refer to the work done in the past by our Committee on Legislation ; it has been very properly brought to our attention year after year. This Committee has endeavoured with considerable success to protect "vested interests," but the time is coming when special vigilance will be in order and it will be necessary for the Association to liberally provide such finances as are required by the Legislation Committee to continue their good work.

I am pleased to report that there is a steady growth in membership and that all our finances are in a flourishing condition.

As previously stated, there have been many changes in electrical developments in Montreal in the last few years, and in order that we may have an opportunity of inspecting these changes our Local Committee have arranged for us to visit the various electrical sub-stations in the city on Thursday afternoon.

I feel sure that if the members who attend this Convention avail themselves of the facilities provided they will derive considerable benefit and the Convention as a whole will be a great success.

Gentlemen, I now declare the Convention open.

K. B. THORNTON, President.

The President : We will now call for the report of the Secretary.

The Secretary, Mr. C. H. Mortimer, then read his report, which was as follows :—

SECRETARY-TREASURER'S REPORT.

The Executive Committee at a meeting in November last closed up all business in connection with the Hamilton meeting of 1904, elected a number of new members, and gave preliminary consideration to arrangements for the present Convention.

It is to be regretted that, owing to the unavoidable absence of our regular stenographer, and the inefficiency of the appointed substitute, no proper record of the proceedings of last Convention was obtainable. Care will be taken to prevent the recurrence of this misfortune.

A Committee was appointed to draft a letter to the chief agents of the manufacturing companies, requesting that at future Conventions the practice of furnishing private entertainment be dispensed with. The members of the Committee were asked to make as widely known as possible the fact that this form of entertainment is to be discouraged.

It was decided to suggest to the Local Committee that this year a mid-day luncheon be substituted for the usual formal dinner.

A Committee was appointed to procure suitable papers, consisting of the President, Messrs. R. G. Black, Toronto, A. E. Evans, Quebec, and D. E. Blair, Montreal. The nine excellent papers to be presented to this meeting are proof of the satisfactory manner in which the Committee have discharged their duty. A special effort has been made to meet the demand for papers which should be instructive to owners and managers of central stations of moderate capacity. In order to save time such of the papers as could be printed and sent to the members in advance of the meeting will be read in abstract.

The present membership of the Association is as follows: Active Members, 285; Associate Members, 126; total 411, showing a gain for the year of 36.

The suggestion has been made that, if possible, branches of the Association should be established at Winnipeg, Vancouver, B. C., and St. John, N. B., thus permitting members prevented by distance from attending the annual conventions to occasionally meet together for the consideration of matters of mutual interest. It is thought that the adoption of this plan would tend to widen interest in the Association and increase its membership and influence. If successfully carried out, it would also permit of the annual convention being occasionally held in Western Canada and the Maritime Provinces.

The receipts and disbursements for the year are as follows :—

RECEIPTS.

Cash on hand June 1st, 1904	$ 25 04	
Cash in Bank June 1st, 1904	817 61	
Refund by Mr. A. A. Dion on account of Question Box	22 06	
202 Active Members' fees	606 00	
74 Associate Members' fees at $3.00	222 00	
2 Associate Members' fees at $2.00	4 00	
		$1696 71

DISBURSEMENTS.

Stationery	6 70	
Exchange on Cheques	6 60	
Postage (including postage on Question Box and Proceedings)	42 30	
Telegrams	1 25	
Express	1 91	
6 large sign cards	4 00	
Expenses on account of Question Box, per A. A. Dion	185 00	
Badges for Executive	2 70	
Refunded to W. H. A. Fraser, over-payment of fees	3 00	
Grant to Secretary	150 00	
Assistant to Secretary	10 00	
Rubber stamp	1 25	
Balance of amount owing Donald Guthrie on account of Legislative Committee (payment of which was authorized at last convention)	126 97	
Balance of amount owing C. H. Mortimer on account of Legislative Committee (payment of which was authorized at last convention)	5 00	
Funeral Wreath	6 25	
Printing	129 68	
Stenographer	20 00	
Cash on hand June 1st, 1905	19 02	
Cash in Bank	975 02	
		$1696 71

Members in arrears for fees who have not responded to requests for payment, are urged to remit to the Secretary. Members are also requested to report promptly any change in their mailing address.

C. H. MORTIMER, Secretary-Treasurer.

Messrs. R. T. MacKeen and R. G. Black, auditors, reported that they had examined the cash book of the Association and found same correct.

Mr. Reesor : I move, seconded by Mr. Purcell, that the Secretary's report be adopted. Carried.

The Secretary : I have a report from the Legislative Committee for Ontario, which I will read in the absence of the Chairman, Mr. Hunt.

REPORT OF LEGISLATION COMMITTEE FOR ONTARIO.

Your Committee was called together on Friday, the 12th day of May last, to consider an amendment to the Conmee Clauses in the Municipal Act of Ontario respecting Electric Light, Gas and Water Works.

Mr. J. P. Downey, M.P.P., gave notice of his intention to move an amendment to the Municipal Act, and later presented a Bill in the Legislature suggesting several changes.

His Bill was considered in Committee on Tuesday, the 16th May, together with a clause in a general Bill entered by the City of Toronto, asking the Legislature to strike out of the Municipal Act all the clauses known as the Conmee Act.

Mr. J. J. Wright, of the Toronto Electric Light Company, and Mr. C. B. Hunt, of the London Electric Company, together with their respective legal advisors, represented your Association before the Municipal Committee, and succeeded in having both amendments defeated, but the Chairman, the Honorable Mr. Hanna, stated that during the next session of the Legislature the Government intended to bring down a Bill making such changes in the Conmee Clauses as they found necessary from past experience of the working of the Act.

It will be the duty of our successors to watch all legislation

very carefully. Funds should be placed to the credit of this Committee to pay necessary expenses.

This year, as there were no funds at the disposal of the Committee, the two companies which Mr. Wright and Mr. Hunt represent paid all legal costs of presenting your objection to any change in the Act, when the matter was discussed in Municipal Committee, but you cannot expect them to do this again.

All of which is respectfully submitted.

CHAS. B. HUNT,
Chairman of Committee.

The President: In accordance with Article XXI of our constitution I now appoint Mr. Black, Mr. J. J. Wright, Mr. Reesor and Mr. Evans as a special committee to strike the names for the standing committees.

Mr Reesor: I move that the committees of last year be re-appointed, and the special committee that you mention be added.

The Preident: Will anybody second that ?

Mr. Evans: Some of the members of these committees may be dead.

The President: That is very true. The Secretary will read the names of the committees that we had last year.

The Secretary reads the different committees.

Mr. Black: That is how many committees now?

The President: Four.

Mr. Evans: There is one name mentioned here, Mr. President, of a gentleman who is not at present engaged in the business.

Mr. Reesor: It is only the names of the different committees that have been mentioned.

The President: Will anybody second Mr. Reesor's motion?

Mr. Black: I second it.

Mr. Black: Before we proceed, Mr. President, I wish to draw attention to a matter referred to in your address, that is, the lack of interest taken by some members in the Association, and I think it would be a good suggestion if the members present here would take extra copies of the papers, and also of the Question Box, and make a point of mailing them to friends who they know should be interested in the Association, and get a definite expression of opinion from them as to why they do not join. The Executive Committee can do a great deal in furthering the interests of the Association but they also require the assistance of the individual members. Now, if each member would make a special point of writing to two or three friends, and get an expression of opinion from them, I think it would extend the interests of the Association very much.

Mr. J. J. Wright: I suggest, Mr. President, that some time be set apart if possible for the discussion of the questions in the Question Box. There are a large number of important matters contained in them, and I think it would be profitable if some time were set apart for their discussion.

The President: I may say personally I only saw the Question Box this morning when I came into the room, and I think the suggestion is a good one. We will try and see if we cannot map out a certain time for the discussion of the questions.

Mr. Black: We might arrange to take time to discuss the Question Box just as it is arranged on the programme, divided into two or three sections.

The President: In the meantime, I think it would be advisable, if there is no other business, that we get to work on reading papers. As there is no further business, I will now call upon Mr. M. A. Sammett to read his paper on the "Effects of Frequency and Voltage on Transformers." The paper appears elsewhere.

The President: Gentlemen, I am sure we have listened to this paper of Mr. Sammett's with the greatest interest, and I am sorry that a larger number of members were not present to hear this splendid paper. I hope there will be a general discussion on this paper, because the subject has been very exhaustively taken up and handled in a most interesting manner.

Mr. Black: Mr. Chairman, I think that the members of this Association are very much indebted to Mr. Sammett for his interesting and exhaustive paper on a subject which all station men are interested in. Members may sometimes object to having techinal papers read to them, but Mr. Sammett has treated a very difficult and complex matter in a method so that almost any person could understand it, after they have taken time to give it a little study. On glancing over the paper casually, a person may not see, just at the first glance, the practical application of this paper to the small central station man, but after they have taken time to digest it, they will find it a very valuable addition to the literature on this subject, and put in a very concise and simple manner. For example, as the load increases on a small central station, it is sometimes found necessary to increase the speed of the generator in order to maintain the voltage at the centre of distribution. A person could easily do this by changing the size of the pulley on the generator, but I question if very many of us have taken the time, or have had the ability, to wade through the books on the subject, to find out just what effect this change of frequency would have on the transformers on the lines. Another way in which it applies to small station men running 133 cycles is when he finds it necessary to increase his plant, and he is recommended to put in 60 cycles machinery. He naturally wants to know whether the 133 cycle generator can at any time be used as a reserve. He also wants to know, and it is absolutely necessary he should find out, whether he has got to scrap all his transformers, and change all his line arragements if he changes the frequency. With the electrical business, as you all know, there is a very heavy peak for say 150 hours each year, and if the old generator could be used during that time, it would keep down the plant account very materially. When we have had time to study all these curves, the central station man will be able to determine for himself just to what extent this might be advisable. Another case, where it applies to the small central station man, is when his new 60 cycle generator might burn out. He would want to know if he could use his old generator, e.i., the 133 cycle generator, or he might have a 60 cycle installation, and want to know if he could run 30 or 25 on his lines by using special taps on large station transformer. In Western Ontario, where nearly everybody expects to use Niagara power soon, it is very necessary that station men should know whether they can make a make-shift in this way, should it be necessary to do so.

Prof. Herdt: Mr. Chairman, I wish also to congratulate Mr. Sammett for his excellent paper. On the first page of this paper, Mr. Sammett states that the energy loss in Eddy current varies as the square of the thickness of the laminations of the iron. Some experiments that have been carried out quite recently tend to show that the Eddy current loss does not increase quite as rapidly as the square of thickness of iron, especially when the laminations exceed one-half a millimeter. This is probably due, although the cause is not fully ascertained, to self induction in the thickness of the pieces of iron. It is also stated that the Eddy current varies as the first power of the specific electric conductivity of the iron, that is, a transformer, when hot, will not have the same Eddy current loss as when cold. With a 50° Centigrade rise, which is of course excessive, the Eddy current loss would be approximately diminished by half. Mechanical pressure on the laminations will also effect the Eddy current loss, the Eddy current increasing with increase of pressure; Eddy current loss varying also with the mechanical treatment of the iron laminations.

Mr. Lambe: I would like to ask Mr. Sammett about the two types of transformers that are generally on the market in medium sizes for pole construction—the high frequency type and the low frequency type. Is it not true that while the high frequency type, as is often stated, will work satisfactorily on a low frequency, the lower frequency type is always the better transformer.

Mr. Sammett: In reply to Mr. Lambe's question, I

would like to say that I perfectly agree with him. Transformers of a lower frequency will prove a better apparatus when used on higher frequencies. As far as temperature rise goes, the radiating surfaces being larger, the transformer will run cooler and consequently last longer than transformers of higher frequencies with same losses and smaller radiating surfaces.

The President: Mr. Leonard, have you nothing to say on the subject?

Mr. Leonard: It seems to me that the subject has been treated very exhaustively in the paper, and the little discussions have been quite to the point as well, bringing out the bearing of this paper on the work of the various central stations. I do not think that much further discussion is required on the matter.

Prof. Herdt: I should like to ask Mr. Sammett, why is it that three-phase transformers are so little used in this country. They have the advantage of a much reduced weight for equivalent capacity, and high efficiency.

Mr. Sammett: The three-phase is a more efficient transformer, a convenient transformer to handle, taking up less space in the station or at the customer's premises. So far it has been objected to only on the ground of the large expense involved in carrying a spare unit. With two or three transformers on a polyphase circuit, any trouble that might result on account of a burn out in a single transformer will be remedied by replacing this single unit, while in the case of a polyphase transformer, the equivalent of the group of transformers will be disabled, and the substitution of the polyphase apparatus would be necessary every time. If transformers were as durable as other alternating current apparatus, thus requiring a minimum number of spare units, the objection of the higher expense involved would be done away with. From a statement made by the engineer of the General Electric Company, I understand that at the present time the kilowatt capacity in polyphase transformers amounts to 30 per cent. of the total kilowatt transformer capacity manufactured at Schenectady, thus showing this type gaining a foothold in America. It is my belief that as soon as the polyphase transformer is made a durable apparatus it will become as universal as it is in the Old Country.

Mr. Higman: I would move a vote of thanks to Mr. Sammett for his very able paper. I am sure that its study will well repay those interested.

Mr. A. A. Wright: Mr. Chairman, I have been requested to second Mr. Higman's motion. It is unfortunate that I arrived so late, and had not the pleasure of listening to the paper, but I have no doubt that it is all that you have said it was, and I have no doubt that the gentleman who wrote the paper expended a great deal of valuable time in preparing it, and I have certainly great pleasure in seconding the motion. Carried.

The President: As there is nothing further on the morning programme, we will adjourn the meeting. At the afternoon session, which commences at 2 o'clock, a paper will be presented by Mr. MacKeen on "Transformers," and I hope you will all be here.

Mr. Higman: Before we adjourn, I would like to call your attention to what has apparently been an omission, that is, the reading of a communication from the Chamber of Delegates of the International Congress at St. Louis, in regard to the standardization of machinery. The subject is a very important one, and this Association has been asked to take the matter up and I hope the communication will not be ignored.

The President: In one respect you are in error, Mr. Higman, for the communication was read to the Executive Committee this morning, and they proposed to take communication of it before the completion of this session, and probably will refer it to the new Executive Committee to take it up very shortly. We had no intention of ignoring the communication. The meeting now stands adjourned.

WEDNESDAY AFTERNOON SESSION.

The convention resumed at 2.15 p.m.

The President: We have a very big afternoon, and are starting a little late. The first paper on the programme this afternoon is one by Mr. MacKeen on "Transformers," and I will now call upon Mr. MacKeen to read it.

Mr. MacKeen read his paper.

The President: I do not know whether it is the wish of the meeting, gentlemen, but this paper has taken a little longer than expected; I think perhaps it would be better if all the papers were read first, and then the general discussion take place afterwards. I think it would be only fair for the other gentlemen to read their papers now, and have the general discussion afterwards. If that is agreeable, I would now call on Mr. William Bradshaw to read his paper on "The Selection and Maintenance of Service Meters."

Mr. Bradshaw read his paper.

The President: We will now call upon Mr. Lambe to present his paper on "Incandescent Lamps."

Mr. Lambe also read his paper.

Mr. Denis: What is the usual position of placing a lamp when running it for life—horizontally?

Mr. Lambe: Life tests are usually made with sockets up above, and the lamp hanging, although you can of course run the test in different positions.

Mr. Higman: The particles of carbon discharged from the filament would be carried out spherically to the walls of the lamp no matter which way it hung.

Mr. Lambe: To tell you the truth, I have not gone into that part of it. I would imagine it would come fairly equal in all directions.

Mr. A. A. Wright: When you say "various times of the day," I suppose you mean various times of the night too?

Mr. Lambe: Yes sir.

Mr. Duncan: What is the price of the Tantalum lamp?

Mr. Lambe: They sell for $1.00 to $2.00, I think, somewhere around that, that is, in the country of production.

Mr. J. J. Wright: What is the name of the lamp?

Mr. Lambe: Tantalum. It is the metal or material of which they are made?

Mr. J. J. Wright: What do you mean by the material of which it is made?

Mr. Lambe: It is the filament that is made of Tantalum. It is one of the rare metals.

Mr. J. J. Wright: There is a question I would like to ask. What is the reason for saying that the bases should be changed, and that the manufacturers are going to make entirely Edison base lamps?

Mr. Lambe: Because it means standardization, and standardization is a benefit in very many ways. As the Edison base was considered the best of the lot for many different reasons, it will gradually come into universal use.

Mr. Higman: It is the survival of the fittest.

The President: I think you will all agree that we have had three most excellent papers this afternoon, and while I know that perhaps some of you may feel a little tired, I hope that fact will not prevent you from discussing the papers, as there is a great deal of value to be derived from a good discussion.

Mr. A. A. Wright: I have listened to the papers with a great deal of pleasure, and I want to ask a question, and that is, why is it that the Edison base is much preferable to the T. H. base? As has been said, from a manufacturers' point of view it is most desirable. That I can readily understand, but from the consumers' point of view I want to know what is the trouble with other bases than the Edison. I have been a user of both T. H. and Edison bases for about 24 years, I think, and I yet have to see any advantage in form or otherwise that the Edison base has as compared with the T. H. I would like to know what is the principal reason for this great change? I always thought that one was as good as the other, and I would just as soon have one as the other, but it is far easier to manufacture ten thousand of one kind than it is to manufacture five

thousand of two different kinds, and if all manufacturers would manufacture one kind of base, then we would get a cheaper lamp. Further, I understand that it was cheaper for the manufacturer to manufacture the Edison base than it is for him to manufacture the T.H. base, and for these two reasons it was better to adopt one particular base, and the consequence is that they adopted one particular kind. It is a rather serious affair, when all your lamps and sockets are of the one kind.

The President: I think Mr. Wright has hit the nail on the head. It is the consumers who are buying the lamps, but they have absolutely no say in the matter at all. The manufacturers have decided to make a change, and we might as well accept it. In connection with the company which I am connected with, we have over three hundred thousand incandescent lamps, of which the major portion were T. H. lamps. We are changing all these lamps to Edison, and expect to have the whole thing done in two years. As soon as we decided to change we refused to take any new or renewal contracts except on the understanding that Edison lamps were to be used. The change is taking place very much more rapidly than we anticipated.

Mr. Higman: Why are you making the change, Mr. Thornton?

The President: The manufacturers have decided that the Edison lamp is to be the standard, and besides, as far as we are concerued, we are only too glad. We supply free renewals to our customers, and it is not in our interest to stock up several styles of lamps with different bases.

Mr. J. J. Wright: I have just looked over the Question Box, and there is one question, No. 57, "What is the best incandescent lamp base to adopt and why?" —the only question in the box that has a large number of answers. The question has eight answers. Seven of the eight are members of operating companies, and every one of the whole eight say Edison.

Mr. Higman: I might say that we are changing all the lamp banks of our testing offices throughout the country to the Edison base, simply because we find it to be a better and more convenient base than others. While on the subject of this paper I might say a word with reference to the photometric value of tests made of incandescent lamps. Very frequently samples of lamps are sent to Ottawa by small central stations to have their candle power value and energy consumption given, and the claims of the manufacturers of lamps are not borne out by actual tests in nine cases out of ten. Something might be said with regard to the standards used in our photometers. The Hefner lamp, of the Reischaustalt, Germany, is used in that country, the Carcel lamp in France, and the Pentane lamp by the scientific bodies in England; but the British Government, with that conservatism which has become proverbial, still clings to the old sperm candle, which has an inaccuracy anywhere up to 10%, while the oil lamps that I have mentioned can be depended upon up to about one and one-half per cent.

Mr. Sammett: Anything that I might say would be a repetition of Mr. MacKeen's remarks. The subject was treated by him broadly and thoroughly. There is one point, however, which would bear repitition, namely, the question as to whether a slightly better core loss should be sacrificed for what is to be gained in a better insulated transformer. As shown on one of the curves, the transformers of six different manufacturers give iron losses that differ but slightly, and therefore a purchaser who selects transformers on the basis of the core loss alone is likely to be misled. While the core loss is a very important consideration, the question of life of the transformer as well as safety of the high tension coils from getting in contact with the secondary winding should be borne in mind. Short life due to either poor facilities for insulating the coils, or excessive temperatures at which they operate, will make the transformer a very expensive apparatus indeed, while inadequate and insufficient insulation between the primary and secondary coils may cause loss of life or property, which is likely to result in a heavy loss to the operating company. Durability, safety and core loss should be considered in the selection of transformers.

Mr. A. A. Wright: I would like to put a question, if somebody would answer it, and that is in reference to the oil in the transformers. The oil in our transformers after a time becomes very thick, and it will not run. I want to know whether the oil will get thin, if it is heated, and whether it is necessary to remove that thickened oil or not.

The President: Mr. MacKeen, I guess you can answer that.

Mr. MacKeen: The continued heating of an oil at high temperatures tends to carbonize the oil to a greater or less extent, which causes the oil to blacken. In oil used to rupture arcs such as in oil break switches, the tendency to carbonize is more pronounced. Arcs which take place in a transformer will also effect more or less carbonization. Blackening of oil from carbonization doubtless reduces the dielectric strength to some extent, but not until the oil becomes thick and lumpy does it interfere seriously with the operation of the transformer and then more as a detriment to cooling than to insulating qualities. Then, oil may become blackened due to the absorption of soluble insulating materials used in some makes of transformers. Blackening in this case does not necessarily indicate a weakened dielectric strength, but thickening from this cause reduces the cooling qualities of the oil.

Mr. A. A. Wright: The oil would all shrink away from the top for one thing, and if the transformers were not quite full we would just give them an additional dose. I was speaking to one gentleman about it—perhaps I need not mention his name. He told me, "We just take the oil out and throw it away," and he said it was just as good without the oil as with it. (Laughter).

Mr. MacKeen: Oil slowly evaporates from transformers which are not absolutely air tight. This evaporation is perfectly natural and must be watched so that the oil does not sink below the top level of the core and coils. Fresh oil should be added to supply losses due to evaporation. Oil cooled transformers should never be operated without oil except, possibly, in cases of the greatest emergency.

Mr. Sammett: It is better to leave whatever oil there may be in the transformer and add a sufficient quantity to cover the coils completely. From my experience I find that oil improves with use and tests made on oil when in use for any length of time will invariably give a much higher result for the dielectric strength than new oil. It may be of interest to state that a test made on oil taken out from the case of a burn out transformer proved to be dielectrically much better than fresh oil. I had no occasion to repeat such tests in order to get definite information, but in this case though the results are paradoxical, they must go on record as an actual fact.

Mr. A. A. Wright: Does it make any difference what kind of oil you use? Could you use linseed oil?

Mr. MacKeen: A suitable oil for use in transformers should possess certain well defined characteristics. These are as follows: A high flashing and burning point; chemical reaction neutral; absolutely devoid of moisture; high dielectric strength, and low temperature cold test. All of these characteristics enter very largely into the selection of suitable oil by manufacturers. Oil recommended and supplied by manufacturers of transformers should always be used in preference to any other oil simply because such oils are selected by them to best fill the conditions. The characteristics above cited are found only in mineral oils, and vegetable oils should never be used. It is undesirable to use what are known as thin oils, or oils of low viscosity, because they usually have a much lower flashing point than more viscous or thick oils. The importance of having oil absolutely free from

moisture can be appreciated when it is known that 1/100% of water in an oil decreases its dielectric strength nearly fifty per cent. A good oil for transformers should possess the following characteristics:

Specific Gravity	.869 – .880 at 15°C.
Flashing Point	190 to 183 C.
Burning Point	209 to 215°C.
Chemical Reaction	Neutral.
Viscosity	61 – at 100°C.
Cold Test	10°C.
Break down at short intervals,	23,000 volts.
Break down,	30,000 to 40,000 volts.

Spark gap for voltage test separated 200 mills, using 1/2" discs.

Mr. A. A. Wright: We will now shunt off onto other matters. I think that the manufacturer who sends you meters should have these meters inspected and pay the inspection just the same as the manufacturer of scales. The manufacturer who sells you scales has to give you certificates with them. Why should not the manufacturer of meters do the same thing? It may be a little selfish on our part, but still it would be only right, I think.

Mr. Higman: You pay the inspection all the same.

Mr. A. A. Wright: That is very true, but you go to your customers and say, "Here is a meter that is inspected," whereas, if you give them one that is not inspected, they sometimes think it is not the proper meter.

Mr. Higman: The Department discourages the practice of testing meters at the place of manufacture, afterwards to be shipped long distances by freight or express. A meter might be accurate when leaving the test room of the manufacturer at Peterborough or Pittsburgh and show great inaccuracy when arriving at Halifax or Vancouver. There are other objections why this practice should not prevail, and among them might be mentioned the fact that the conditions under which the meter is to be used are wholly different in some instances from those in the manufacturers' test room. I have a case in mind now where it was found impossible to bring a number of meters within the three per cent. limit of error owing to some inherent defect in the generator. On the surface everything appeared to be right. The voltage and frequency demanded by the meter were there; but there was something else that could not be seen, probably a serious distortion of wave form, which put the meters outside the limit as to accuracy. These meters, among the best on the market, will have to be recalibrated to suit the local conditions. While on my feet I would like to say a word in respect of Mr. Bradshaw's very excellent paper on electricity meters. No one, I am sure, will take objection to the list of requirements that he has laid down. It might be stated that the Department requires that every new meter, before it is placed on the market, shall be submitted to the Electrical Standards Laboratory for examination and report. The nature of the tests to which these meters are subjected may be enumerated thus: 1. A test for sensitiveness. For this test a starting current equal to two per cent. of the full load capacity is used. 2. Accuracy. Loads varying from quarter up to full load and down again. 3. A test as to the effect of the application of external magnetism. 4. A test as to the effect of variation in voltage, frequency and wave form. 5. Fall of potential in the series coil; resistance, location and energy consumption of the shunt coil. A test for durability is desirable but this cannot always be applied. Usually meters are submitted to the department with the request that we telegraph on receipt whether the meter is approved or not. In one instance a meter was before the department two years, during which time it was reconstructed throughout two or three times before it would test out correctly. Referring again to Mr. Bradshaw's paper I might say that the frequency curve shown is theoretically correct and desirable, but in practice unfortunately we find the departure from accuracy occurring at a much earlier period in the variation.

Mr. A. A. Wright: How long has that been the law, Mr. Higman, that every meter should be tested?

Mr. Higman: Since the Inspection Act was first put in force. When a new meter is approved by the Department, a circular is issued to the inspectors. The inspectors refuse to inspect a new meter until this circular is received.

The President: I am afraid it is getting a little late to take up any of the questions in the Question Box, although it is on the programme to take them up this afternoon. Is there any more discussion on these papers?

Mr. MacKeen: I would like to ask, Mr. Higman, do you insist on meters being tested at their normal rate of voltage, and do you insist on meters being tested by direct current or alternating current?

Mr. Higman: We invariably test meters under the conditions called for as to voltage and frequency. The electric lighting company provides the testing current.

Mr. A. A. Wright: I do not wish to be noted for my much speaking, but I am here for information. I would like to know where is the best place to put a meter in a house. If it is in the bedroom, and there is somebody sick in that room, and you go there to read the meter, you cannot get in and you will have to wait for another month. If you put it in a clothes room, it is so dark you cannot see to read that meter very clearly. Then, if you put your meter in an out of the way place, your man cannot get at it in case of fire. I have been thinking if down the cellar-way would not be a very good place.

Mr. Higman: The Departmental Regulations require that the meter shall be so placed that it can be conveniently read by the inspector, or by whoever wishes to read it. I do not know that the inspectors always insist on that, but I think they should.

Mr. A. A. Wright: But the question is where to put it.

Mr. Fisk: I might say we have had six or seven large fires in Peterborough in my memory, and we have only lost one meter. We have had three meters in buildings which were entirely destroyed, which came out all right.

Mr. A. A. Wright: Where do you put them?

Mr. Fisk: We try to put them in the attic if possible, right where the service wires come in. We find this a very convenient place.

The President: We insist upon meters being located at the point of entrance of the feed wires, and in such a position that they can easily be read by our meter reader. Our contract is so worded that the customer is entirely responsible for the meter on his premises in case of fire.

Mr. A. A. Wright: That is a new point for me.

The President: That is the only way to do it.

Mr. Higman: Section 5 of the Inspection Act makes the owner or contractor responsible for the proper condition of the meter and all other appliances owned by him on the consumers' premises.

The President: If you will refer to our contracts, you will see that is the way they are made, and I have known many cases where the customers have paid for damaged meters.

A Member: I would like to ask a question in regard to a point that has occurred to me in reading over the Act. It seems to read in a way that nobody but the Government may test a meter, to find out whether it is accurate or not.

Mr. Higman: A few years ago a couple of smart men came over from the other side and started a bureau in Toronto called the "Standard Meter Bureau." They succeeded in frightening the people as to the condition of their meters, saying, "We can save you hundreds — it may have been thousands — of dollars by testing your meters for you," and incidentally they charged four or five dollars for their test. We knew that that test was unnecessary, and in order to put them out of business we amended the law, which states that no one but the inspector shall test and give a certificate as to the accurateness of a meter. There can

be no objection, as I understand it, to thê electric lighting companies testing their meters as often as they please, provided they do not break the seal. They can test it in situ without breaking the seal, but if the meter is removed and the seal broken, then a new test by the inspector must be made before it can be fixed for use again.

Mr. Bradshaw: Do you allow removal of the meter at all. Many companies have no provision for testing on the premises. Are they allowed to take them to their laboratory for test, if the seals are not broken?

Mr. Higman: Yes, so long as the seal is not broken.

Mr. Lambe: The act says "every person." That means that even the owner of the meter, as I read it, has no right to test that meter.

Mr. Higman: The construction would be as to what constituted a test. The definition might have been a little better. It was never intended that it should prevent the company from ascertaining the condition of its meters.

Mr. A. A. Wright: I might say that I was in the House at the time this law was amended, and I voted for it, because I thought it was a good thing. As Mr. Higman has just said, if these people came to the large cities and went around to our customers, and told them that their meters were all wrong, and that they were being swindled out of so much money, they would cause all our customers to be affected with the fear that the meters were wrong, and that they were being cheated, and that the electric light men were a lot of swindlers.

Mr. Lambe: Another curious point that I have noticed is that the Act says, "Within 12 months after the expiration of five years." This means, does it not, that the meter has to be inspected only every six years?

Mr. Higman: We could not, of course, say exactly five years. There has got to be some leeway for the bringing in of the meters. If you said five years, legally you could be tied down to the very day. Manifestly, you could not do that.

Mr. Fisk: It is a very good thing.

Mr. Higman: We might have said within two months, or some such time, but we thought that one year would be less onerous on the companies.

Mr. Lambe: Why?

Mr. Higman: An interim test may be made at any time either by the company or by the consumer, a test for which only fifty cents is charged, irrespective of the capacity of the meter, so that every facility is offered in that respect.

Mr. Fisk: I don't believe that a company could keep out a meter for five years.

Mr. Wright: I believe you are right, too.

Mr. Higman: Well, we thought it preferable to put the electric meter on the same basis as the gas meter, which is five years.

Mr. A. A. Wright: Well then, you reinspect any time before that for fifty cents.

Mr. Higman: Any time.

Mr. A. A. Wright: We will have all our meters tested after they have been out for four years and eleven months for fifty cents each.

Mr Higman: Meters are now systematically cleaned and tested by the companies before they are submitted to the Government officers for inspection, and I think the Department may reasonably claim some credit for this improved condition of affairs. During the first year of the inspection more than 50 per cent. of the meters were rejected as being inaccurate. Meters as manufactured to-day are fairly dust-proof and many of the types will stand up against a five years' run, but at 50 cents for each test they can be taken down every week if necessary.

Mr. Bradshaw: I don't believe that anyone ought to leave a meter out five years. I do not care how good it is, it would be better to pay his fifty cents and have it attended to before that time. The best companies in the States, using various makes of meters, rarely let them run over a year's time, and he ought to have his department fixed so that he could test them every year. In the end you will save money by having a systematic test in some simple way, which will tell you how the meter is.

The President: I think that is the practice with some of the large companies in Canada that I know of. It would be almost impossible to test all your meters in one year, unless one had a very large staff, which would increase the operating expenses very considerably. We watch the behavior of our meters in a good many ways. We endeavor to have an annual inspection of all customers' premises once a year. While inspecting the premises, the inspector checks up the meter, and, in addition, our billing department analyses the readings as taken by the meter readers, and the very instant there is any disrcrepancy in readings, that meter is checked up right off. If there is any doubt the meter is taken down and tested. The meter readers are also instructed to test doubtful meters by turning on a light.

Mr. A. A. Wright: I would just like to ask Mr. Bradshaw how they do. Our way is this: I send a man around with a five candle power lamp. We take off the lamp and put on the five c.p., and if it starts on five c.p., we take it for granted it is all right. Now, is there any better way than that?

Mr. Higman: I might say that an employee of one of the electric companies informed the Minister of our Department that he had a scheme whereby he could make the meters go fast or slow without going near them, and as I understand it, challenged the Department to find out just what it was. I am aware that by reducing the speed of the generator and consequently the frequency, alternating current meters can be made to go fast. In doing this the machine would have to be over excited in order to maintain the voltage. I do not think, however, that companies would resort to such an expediency to defraud the consumer. Notwithstanding, I think it may be necessary for the Department to regulate the variation of frequency in the same way as the electrical pressure is now regulated. I would like to avail myself of the present opportunity of saying a word to the manufacturing companies, and it is that the Department will require them to supply with their meters more exact information in respect of their characteristics. It is necessary that they should fix in some conspicuous place on the meter cover a small plate on which should be legibly stamped or engraved the following information: (a) the manufacturers' shop number; (b) the amperes; (c) the volts; (d) the frequency in cycles; (e) the number of revolutions per minute of the rotating disc when the meter is working under full load. I am aware that the volts and amperes are usually given on the dial plates of most meters; the frequency is pasted on the back of some and the rotating constant is usually contained in a pamphlet that cannot always be found when needed and often involved in an equation that is not easily understood by those immediately concerned. The information I have outlined can be put into a small space and it is all the information that is needed to make an intelligent test of the meter.

Mr. Fisk: In regard to that variation of frequency, I think this must have been a very small plant.

Mr. A. A. Wright: And a small man, too.

The President: I know in our company we must have our frequency absolutely constant, and have apparatus to show us that it is so, so that if the meters are tested for frequency we never have any trouble.

Mr. A. A. Wright: I would like to have an answer to that question with reference to the testing of the meters.

Mr. Bradshaw: Of course, that gives you an indication of whether the meter will actually run or not. A lamp 20 watts, that is a good light to test it on, but that is no test as to the accuracy of the meters. It might be 20 or 25, and one would not know whether it was or not if you did not have an instrument to check it. One way is to take some form of integrating standard, which is pretty generally in use all over the States now, and meters are being made specially for that

purpose, with two or three series coils, so that any meter will contain in itself different capacities for all meters that the central station would have, and a man can make a test on the meters in service almost as quick as he can make the inspection. I know of at least three big companies, one in Pittsburg, one in New York, and the other in the west, where they are using that method entirely, and the manufacturers are now coming to that point that they are making these special meters for high power work, and it seems to be the cheapest and most reliable method for full service.

Mr. Fisk: In our company we have a very good scheme. We have incandescent lamps of different candle power on a board which can easily be carried around. This small bank of lamps is checked up with a standard watt meter at the office, on different voltages. This with a volt meter and stop-watch makes a very good outfit for portable work.

Mr. Bradshaw: This method is in use in a good many states, too.

Mr. Leonard: I would like to move a very hearty vote of thanks to Mr. R. T. Mackeen, Mr. William Bradshaw, and Mr. A. B. Lambe, the authors of the three interesting and very able papers read to us this afternoon. Carried.

The Convention then adjourned until the following morning.

SECOND DAY.

The Convention resumed at 11 a.m.

The President: It is absolutely necessary, in order that the programme may be carried out as arranged, that we get through in time to be over at the Windsor Hotel by 12.45. Unless this is done, we cannot complete our programme. I hope that the balance of the members will come in as the morning proceeds. Mr. Higman yesterday referred to a resolution of the International Electrical Congress. I will now read his letter.

Ottawa, April 28th, 1905.

Secretary Canadian Electrical Association, Toronto.

Dear Sir: In accordance with a resolution adopted by the International Electrical Congress at St. Louis in September of last year, I have the honor to submit for the information of the Canadian Electrical Association copy of a resolution adopted by the Congress in relation to the International standardization of the nomenclature and ratings of electrical apparatus and machinery.

I shall be pleased to receive at an early date the views of the Executive of your Association with regard to the proposal; and whether in the event of the formation of an International Electrical Congress your Association will be prepared to appoint a representative for Canada.

It will be observed by reference to the "Proceedings" that this Congress relates to the standardization of electrical machinery and not to electrical units of measure. The Congress on thelatter subject will be composed of delegates appointed by the various governments.

Awaiting your earliest reply, I remain, Sir,
Your obedient servant,
O. HIGMAN,
Delegate of the Government of Canada

RESOLUTION OF CHAMBER OF COMMERCE.

The following report was received and unanimously adopted from the committee on international standardization:

"The committee of the Chamber of Delegates on the standardization of machinery begs to report as follows:

"That steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardization of the nomenclature and ratings of electrical apparatus and machinery.

"If the above recommendation meets the approval of the Chamber of Delegates, it is suggested by your committee that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystallize the points of disagreement, if any, which may arise between the methods in vogue in the different countries interested.

"It is hoped that if the recommendation of the Chamber of Delegates be adopted, the commission may eventually become a permanent one."

Mr. J. J. Wright: Mr. President, I move that the communication be referred to the new Executive, to take action in the matter.

Mr. Higman: Before this motion is passed, I would like to call attention to the resolution. I may say that the matter was primarily taken up by Col. Crompton, of London. He has for some years been collecting data on the subject, and has spent several thousand pounds, he tells me, of his own money in forwarding the project. The Congress at St. Louis decided to second his efforts in that respect, and the following resolution was passed in the Chamber of Delegates: "That the delegates report the resolution of the chamber as to international standardization to their respective technichal societies, with the request that the societies take such action as may seem best to give effect to the resolution, and that the delegates be requested to communicate the result of such action to Col. R. E. B. Crompton, Chelmsford, England, and to the president of the American Institute of Electrical Engineers, New York City." As will be seen, the submitting of this resolution to the technical societies of Canada devolved upon me, and I may say that the Canadian Society of Civil Engineers have notified me that they are in perfect accord with the aims of Col. Crompton and the proposed international commission. It will, however, devolve on this Association to select the delegate to represent Canada on the commission. As the commission is to deal with the standardization and rating of electrical machinery, the choice of a delegate will necessarily have to be made from among the manufacturers or consulting electrical engineers, and I have no doubt that the Council of the Association, or the Executive, will be able to meet the requirements of the case. When the delegate has been chosen, and reported by me, my duties in regard to the matter will have ended.

Mr. A. A. Wright: Mr. Chairman, I have much pleasure in seconding that resolution.

The President: It has been moved by Mr. J. J. Wright and seconded by Mr. A. A. Wright that this matter be referred to the Executive. Is that the wish of the meeting? Carried.

The President: The first paper on our programme is one by Mr. A. L. Mudge entitled "The Operation of Alternators in Parallel." I am extremely sorry that Mr. Mudge is not able to be here himself. As I did not arrange to get any person to read the paper, I am obliged to read it myself.

The President: It is most unfortunate for us that Mr. Mudge was not here to read the abstract of his paper himself, as he could have dilated upon the little points that have come out in his paper as he went along. I personally have not had the time to read through or thoroughly digest this paper, and I am sorry. as I am therefore unable to do full justice to it, but the points mentioned are well known to all station operating men, and as there are a good many station operating men here who are familiar with the points raised, I hope that we will now hear a few words from some of them. I think it is advisable to have the discussion immediately after the papers are read. We tried the method of reading all the papers first, and having the general discussion afterwards, yesterday afternoon, and it was not a success; so if there is going to be any discussion, I would ask the members to rise promptly and discuss the papers, in order that we may carry out our programme in due time.

The President: Have you anything to say, Mr. Burson?

Mr. Burson: With regard to synchronous motors, they are the most satisfactory drive for operation of generators in parallel, such as the Shawinigan station. That type gives a speed absolutely constant. With an induction motor speed depends naturally upon slip, and the slip depends on the resistance of your rotor. Hence it is a very hard thing to make two machines exactly alike as regards full load speed. If you can get your two induction motors to have the same slip at full load, and you operate them both at full load, then your two A. C. generators will be driven at the same speed, and will have the same frequency. But the operation is not as satisfactory as with the synchronous motors. As regards the motor being two or three phase, it makes no difference in operation.

Mr. Lambe: I would like to ask if three phase

motors give a more uniform drive than two phase, also if the angular velocity of a three cylinder engine is more uniform than the angular velocity of a two cylinder engine as applied to parallel operation of alternators.

Mr. Black: On various occasions I have required to look into the matter of parallel operation, and I think I am in a position to answer Mr. Lambe's question. The angular velocity of the three cylinder engine is practically the same as the two cylinder engine, i. e., cranks set at 120 degrees and cranks set at 90 degrees give practically the same results as far as the parallel operation of A. C. machines is concerned. With reference to the synchronous motors driving A. C. generators, and also induction motors driving A. C. generators, several interesting problems come up. When you use a synchronous motor or induction motor to drive an A. C. generator there is generally a difference in frequency, that is, you have 25 or 30 cycles, and you require to change to 60 cycles. Where you have 30 cycles there is no difficulty in paralleling on the 30 cycle end and also on the 60 cycle end, as you have just half the number of poles on the motor that you have on the 60 cycle generator. When you have 25 cycles and wish to change it to 60 cycles it is a little more difficult, as 25 and 60 are not multiples of each other. Hence great care has to be used in selecting the proper number of poles on both motor and generator. This was first noticed, I believe, in the Buffalo sub-station supplied with 25 cycle current from Niagara Falls. The synchronous motor had eight poles and the 60 cycle generator had 20 poles. It was found that when the motors were put in parallel that some times it was impossible to parallel the 60 cycle end. Upon investigation it was found that there were just four points at which both the 25 cycle end and the 60 cycle end of the units could be paralleled. With other combinations of poles it becomes more difficult to parallel. Another interesting problem which comes up when using synchronous motor frequency changers which Mr. Burson might have told us about when he referred to the frequency changing sets at the Shawinigan sub-station, which we hope to have the pleasure of seeing in operation this afternoon, is the difficulty of making the last unit put on the bus bars take its share of the load. As the switching in and dividing the load on an A. C. generator driven by a synchronous motor has to be treated differently than a unit driven by an engine or water wheel, the operation in multiple of frequency changers driven by synchronous motors is of considerable interest. Imagine an A. C. generator driven by a synchronous motor to be in operation and a second unit to be connected in parallel with the first. Imagine that the first set is carrying full load and that the second set is to divide the load with it. The motor end of the unit can be parallel in the usual manner by adjusting the full current so that the potential difference between the bus bars and the synchronous motor vanishes and then closing the switch connecting it with the bus bars the instant they are in step. If the generator end of the set is synchronized in the same way it is not possible to make it take any load. If the field current of the 60 cycle generator end is diminished or increased the load on the frequency changer remains unaltered, and the effect of changing the excitation results only in an increase of the cross currents between the two sets. Now, in order to make the second set divide the load with the first, it becomes necessary to abandon the usual method of paralleling and to do so in the following manner: First parallel on the motor end in the usual way and then when paralleling on the generator end of the set make the field current of the new unit the same as on the loaded unit. Then when they are in step close the switch connecting the second unit on the bus bars and the machines will divide their load. It is necessary, of course, that the machines have the same characteristics. Any person who is interested in this particular case of parallel operation will find a good article by Dr. B. A. Behrend in the Electrical World, February 13, 1904. With reference to the parallel operation of A. C. generators driven by induction motors, there are also a few points which require attention, as the method is different from the usual procedure when engines or water wheels supply the motive power. For example, suppose you have an A. C. generator driven by an induction motor fully loaded and as your load is increasing you wish to put another machine on the bus bar. Suppose the load came up quickly and there is a heavy overload on, then your speed will be say 4% below synchronism. When you start up your new set, also driven by an induction motor, it will run at synchronous speed, as all induction motors run at synchronous speed when not loaded. It will therefore be necessary for you to open the switch on the induction motor and parallel on the 60 cycle end when your speed is falling, then close your induction motor switch again. I am assuming, of course, that your induction motors are of the squirrel cage type. These various points which I have mentioned do not make the parallel operation of the units any less satisfactory, but would merely cause a person to do a little thinking if he should attempt parallel operation without knowing the tricks of the trade, as it were. Before resuming my seat I would like to ask Mr. Burson a question in reference to induction motor frequency changing sets. As you all know, one of the big objections to large squirrel cage induction motors is their heavy starting currents. Now, as I explained a few moments ago, it is necessary in starting and paralleling one of these sets to throw the induction motor on and then take it off and then put it on the second time. What starting current will it take the second time the switch is closed?

Mr. Burson: It will take the current which it will have if it were operated running on the line, with a slip of 4%. It will not take the full load starting current.

Mr. Pratt: I would like to ask if there would be any difficulty in synchronizing two generators, one water wheel driven, and one steam driven, the steam generator being run at much higher speed than the water wheel driven unit.

The President: We have operated generators that are run from water power plants, in parallel with generators in other stations operated by steam, and experience no difficulty. We receive power from water power plants at Chambly, Lachine and also at Shawinigan, and also have auxiliary steam plants. We have connected those various stations, and we have no difficulty whatsoever in paralleling the steam plants with the water wheel plants.

Mr. Black: Mr. Pratt's problem is a little more difficult than appears on the surface. I think he refers particularly to 133 cycle generators.

Mr. Pratt: We expect to change to 60 cycle.

Mr. Black: Well, then, it largely depends on whether your machine is direct driven or belt driven, and it also depends on the nature of the governor of your engine. If it is a fast running machine, then there should not be any trouble at all, particularly if your water wheel capacity is large in comparison with the belted unit which is driven by the engine. In the case Mr. Thornton refers to, we found that by having the water wheel units on the line first, and putting everything in parallel with them, there was no difficulty at all. We could parallel engines that would not run in parallel by themselves, provided that they had the water wheel even angular velocity to steady them up. After you have started a number in parallel, then you could put almost anything in parallel with them.

Mr. Pratt: In this case the generator will be belt driven, and the engine will be high speed.

Mr. Black: How many cranks will you have?

Mr. Pratt: One.

Mr. Black: I don't think you will have any difficulty.

Mr. Lambe: As a general rule, are not the difficulties of parallel operation rather exaggerated. I know a case where a couple of belt driven machines, high frequency, dissimilar make, are being operated on

the same circuit in the same station, and are thrown in or out of parallel with the greatest ease. Then there is another point that also strikes me as being contrary to what would seem to be the general opinion, namely, the further apart you have your stations the easier it is to parallel them. The worst case is when your machines are side by side in the same building and direct connected to engines the velocity of which is not regular.

The President : I think what Mr. Lambe says is perfectly true—that there is a good deal of exaggeration, and if you ask a station operator, he would say there was no difficulty at all. Is there anybody else why has had experience with parallel operation ?

Mr. Macfarlane : I can only say that I have not had very much trouble in paralleling, and have come to the conclusion that practically any combination of engine and water wheel driven generators can be successfully run together, and have usually found this the most satisfactory way to operate even when the different units were some distance apart.

Mr. Fisk : In order to see that your synchronizing lamps are all right, it is a very simple thing to simply disconnect the terminals from one machine, and energize all the transformers from the other, and note if the synchronizing lamps show synchronism. If the lamps do not show synchronism, the connections should be so changed so that they will. If this rule is adhered to, it does not matter if the transformers are of different make, they are bound to come out alright. I think this is a point which should be emphasized, as an inexperienced man may have a great deal of difficulty in trying to operate his machines in parallel because he has not got his phasing lamps properly connected.

Mr. Macfarlane : As to whether the machines are to be thrown together when the synchronizing lamps are dark or bright I think a very good way is to disconnect the leads close to the incoming generator and then close the switch of that generator the synchronizing lamps will thus either be bright or dark according to the way the transformers have been connected, and this is the condition the lamps should be in when the generators are thrown together.

The President : Well, gentlemen, if there is no further discussion I will proceed to the reading of the next paper. I will now ask Mr. A. J. Burson to present his paper on "Induction Motors." The paper appears elsewhere.

Mr. Burson : It is the aim of the above paper not to go fully into the theory of the polyphase induction motor, but to start a discussion. In my opinion more is to be gained from a live discussion than in any other way.

The President: Well, gentlemen, let us have the questions.

Prof. Herdt : Accurate testing of large induction motors is, as you know, difficult, besides requiring large amount of electrical power to carry out the test under full load. An accurate method for predetermining their performance without undergoing load test is evidently of great value. Having had occasion to test a number of induction motors, and also applying the circle diagram method, very satisfactory results were obtained and demonstrated the very close limits within which it works out. The circle diagram as shown to us by Mr. Burson is, however, of still more value for designing and allows the designer to work out clearly and with certainty a machine to give a desired performance. It is a pleasant duty for me to congratulate Mr. Burson on his able paper, for I have had the good fortune to have Mr. Burson as a colleague, he having left us only a few years ago. Since that time Mr. Burson has made a specialty of induction motor design, a subject of which he has by his paper to-day shown himself to be the master.

Mr. Black : I would like to ask Mr. Burson if this circle diagram can be applied to induction motors of the same type as made by the Stanley Compan, and whichy were exploited in Canada by the Royal Electric Company? They differ considerably from the motors now on the market.

Mr. Burson : The circle diagram can be applied to any induction motor, since it is theoretically correct. I might say that in our test room we make a complete test and circle diagram for each motor, and hence are able to determine accurately its performance, and where the design may be altered to advantage.

Mr. Black: How does the theoretical efficiency as taken from this diagram compare with that as given by the brake test ?

Mr. Burson: It compares very well. The only difference which may exist will be in the resistance losses in the stator and rotor. If both the circle diagram and brake test are carefully made, the variation should be negligible.

Mr. Black : In the squirrel cage type of motor the rotor resistance is very low, is it not ?

Mr. Burson : Yes, the resistance is low, but not so low necessarily as the resistance of a coil-wound rotor. As has been stated, the starting torque is proportional to the rotor resistance loss. In a squirrel cage motor, the rotor resistance is a fixed quantity, except for changes due to temperature, and if a large starting torque is required, the resistance of the rotor must be higher than if a small starting torque is required. In other words, an increase in resistance, within certain limits, results in an increase in starting torque. In the case of the coil-wound rotor, external resistance is introduced when starting and is cut out when the motor is up to speed.

Mr. Bucke : How do you measure the resistance of a squirrel cage rotor ?

Mr. Burson : The resistance of a squirrel cage rotor cannot be measured directly. The resistance loss, however, can be measured, and the effective resistance calculated. The resistance loss is determined by means of the static torque measurement, which is made as follows: In the stator circuit is an ammeter, voltmeter and wattmeter. On the rotor shaft is clamped a beam carrying a weight which is balanced against the electrical torque. This torque in foot pounds may be plotted against volts on the stator. More generally, however, the torque is expressed in synchronous kilowatts, that is, the output of the motor at synchronous speed for a certain torque value in foot pounds. It is equal to

$$\frac{WR \times 2\Pi n \times = 746}{33{,}000} \qquad \begin{array}{l} WR = \text{torque in foot pounds.} \\ n = \text{revolutions per minute.} \end{array}$$

From this value may be deduced the effective resistance.

Mr. Black: If the resistance of a coil wound rotor is very low, what means are taken to measure it ?

Mr. Burson : It may be measured by the ammeter-voltmeter method.

Mr. Lambe : How is the current in a squirrel cage rotor measured ?

Mr. Burson : The current in a squirrel cage rotor cannot be measured directly. If we neglect leakage, the number of ampere turns on the stator is equal to the number of ampere turns on the rotor. This value divided by the value of rotor bars gives the effective current per bar. Dividing the synchronous kilowatts by the square of the effective current gives the effective resistance. The current distribution may be worked out theoretically, but this is quite complicated.

Mr. Denis : You spoke of increasing the starting torque by increasing the rotor resistance. Do you get the same effect by introducing an auto-transformer in the primary ?

Mr. Burson : The effect is not the same. The auto-transformer is used to reduce the starting current by reducing the applied primary voltage. As has been shown, this results in a reduction, and not an increase in the starting torque.

Mr. Black : Could Mr. Burson give me this information about the induction motor ? Supposing that after it had been running a while, the bearings wear and the

rotor gets off centre, what effect is that going to have on the operation of the motor?

Mr. Burson: It will have no noticeable effect until the bearings have worn to such an extent that the rotor rubs on the stator.

Mr. Lambe: When the rotor is off centre will not the magnetic field distribution be affected?

Mr. Burson: Yes, it will; but that will have no effect on the operation of the motor.

Mr. Black: Supposing a man buys a motor which he presumes is large enough to run his factory. He finds it will not start the load and is in a quandary to know what to do. I have known cases where the man in charge would saw the short circuiting rings between the rotor bars. I would like to ask if there is any better way of increasing the starting torque.

Mr. Burson: The only way to increase the starting torque of a squirrel cage motor is to increase the rotor resistance. This is done by decreasing the cross section of the short circuiting rings. Sometimes the starting torque of a motor—and hence its slip—will increase materially after the machine has been in operation for a time. This is due to the contact resistance between the rotor bars and short circuiting rings increasing.

Mr. Hilliard: How much can you increase the starting torque by increasing the rotor resistance?

Mr. Burson: The amount depends altogether upon the design of your machine.

Mr. Hilliard: Supposing you require a motor with high starting torque and low slip, would you recommend the use of a squirrel cage motor and a clutch?

Mr. Burson: That arrangement can be and is used with success. There are cases, however, in which it has not been entirely satisfactory on account of the character of the load. A motor with a coil wound rotor would give much better results. It would be more expensive, and take up a little more floor space, but the results would more than counterbalance these disadvantages. In purchasing a motor, it is best to explain to the company supplying it the exact conditions under which it is to operate, since their engineers are then able to decide upon the type best suited to the work.

Mr. Black: Mr. Burson speaks of the motor with a coil wound rotor being more expensive than a squirrel cage machine. On a 50 h.p. motor, what would this amount to?

Mr. Burson. I really could not say. The selling price is a question for the sales department.

The President: Too much starting current is a very objectionable feature. In the company which I am connected with, we insert a clause in our contracts stating that the motor will not introduce a disturbance on our circuits. In some instances we have had to insist on a consumer installing a clutch for starting purposes.

Mr. Black: Take the opposite condition, where the slip is too great, what method would you suggest of reducing it?

Mr. Burson: If the motor initially had too great a slip the only thing to do is to put in new short circuiting rings with less resistance.

Mr. Lambe: Is it necessary that an induction motor should have a very small air gap?

Mr. Burson: That altogether depends upon the guarantees which have to be met. As has been explained, other things being equal, a high power factor means a small air gap. The leakage factor varies, for small gaps, directly as the length of gap. The maximum power factor obtainable is equal to $\frac{1}{2\sigma + 1}$ where σ = leakage factor.

The President: As Mr. Wright suggested, we are here for information, and it seems to me we are getting quite a lot of it.

Mr. Black: I would like to ask Mr. Burson what he considers to be the highest voltage it is wise to use for induction motors, say a 50 h.p. motor.

Mr. Burson: It is not good practice to wind any induction motor for a higher voltage than 2500 volts. Of course, there are special cases in which as high a voltage as 66,000 may be used. For motors up to 75 h.p. 550 volts is about the best voltage to use, and above 75 h.p. 2200 volts is more desirable.

Mr. Black: Do you consider a 25 cycle motor better than the 60 cycle motor.

Mr. Burson: The 25 cycle motor is no better than the 60 cycle motor, except in cases where a very slow speed is necessary.

Prof. Herdt: In Germany, I think it is specified in all contracts that the motors shall have coil wound rotors. In fact I have seen very few squirrel cage motors over 15 or 20 h.p.

Mr. Burson: Labor is, of course, much cheaper in Europe than in this country. Also the coil wound rotor has reached a higher state of perfection there. Another reason for the use of this type of motor is that the European power company cannot and will not allow the heavy starting current necessary for a squirrel cage motor.

The President: I think some of us will have to put that restriction in our power contract.

Mr. Black: One great drawback to the induction motor is that when it is running light the power factor is very low. I would like to ask if there is any way of increasing the power factor at light loads.

Mr. Burson: The power factor may be increased by the use of capacity in the motor circuit. This however, is not altogether practicable.

Mr. Black: I take this opportunity to move a very hearty vote of thanks to Mr. Burson. I am sure we have derived a great deal of information from Mr. Burson's paper, and the thanks of the Association are due to him for the way in which he has answered the questions which have been put to him. Carried.

Professor Owens' paper came next on the programme, but owing to the unavoidable absence of the author, it was not presented. Prof. Herdt, however, kindly consented to explain certain curves and diagrams in connection with recent experiments as to the heating of enclosed conductors which had been made at McGill University, which was much appreciated and brought forth an interesting and instructive discussion.

The President: Is it the wish of the meeting that we now adjourn. It is now about half an hour before the cars will leave the Windsor. That will just give us time to walk up there, unless, of course, there are some questions that the members would like to bring up now, or any information that any member would like to have. As you have probably noticed, there has been a list placed at the Hotel for those who care to take the trip to Shawinigan Falls on Saturday. Of course, if a sufficient number do not signify their intention to go, it is impossible for us to ask for a special train, or to make any arrangements. This afternoon there are the visits to the sub-stations. We are leaving that rather open. One of the finest sub-stations in this city is in Maisonneuve, where the 50,000 volt current of the Shawinigan Power Company is brought into Montreal, and stepped down for local use. The Montreal Heat, Light & Power Company have a large sub-station adjoining the same, on the other side of the building. They have a very large synchronous motor, 5,000 K.W., a very large switchboard, etc., and altogether there is a lot of interesting data for men who are down here "looking for information," as Mr. Wright said. There is time this afternoon, after we get back, to go to some of the different sub-stations. I have just mentioned these as there are too many for the delegates to see in the short time that they are here. As there is nothing further, gentlemen, we will adjourn.

During the afternoon the members visited the stations of the Montreal Light, Heat and Power Company and the works of Allis-Chalmers-Bullock, Limited.

THIRD DAY.

The President: Following the plan of the programme, the first paper is that of Mr. Aitken on the "Economy of Isolated Plants." Unfortunately Mr. Aitken is unable to be present, so Mr. Campbell has kindly consented to read the paper for him.

Mr. Campbell then read the paper.

Mr. A. A. Wright: Well, gentlemen, I am sure we are very much indebted to Mr. Campbell for having read this paper for Mr. Aitken. It is certainly unfortunate that he is not here himself to answer any questions we might choose to ask, but under the circumstances we will have to do the best we can. I might say that I have no doubt myself that Mr. Campbell will be able to answer any questions on this point that you will ask from him. It is now before you for discussion, and I hope some of you will take advantage of it.

Mr. Campbell: I might say, Mr. Chairman, not being a central station man, I do not propose to discuss this paper in any way, but there are a number of station men and electrical engineers here, who no doubt have had experience in figuring out these problems the same as Mr. Aitken has done in his paper, and I would suggest that the central station men who have large plants under their control should get at this thing very vigorously, and fight it out to a finish.

Mr. Black: I think Mr. Aitken has given us a very valuable paper on a subject about which a great deal of misapprehension exists. The public have erroneously got the idea that all central station men are highway robbers and that they can do much better themselves by putting in isolated plants. Mr. Aitken has touched on the vital question of this problem, viz., the load factor. Most people do not understand why it is that central stations have to charge more for one class of service than another. A man has a general store or departmental store, and is selling one yard of cloth at the same price as a thousand, and he cannot get it through his head at all why it is that the central stations have to make a difference, due to the nature of the load which is going to be provided. Mr. Aitken's paper is of especial value, because it is based on actual experience, and actual experience is always ahead of theories, which sometimes do not come out just as they are expected to. Mr. Aitken is an engineer who has given a great deal of attention to this work, and he is capable of drawing very careful and accurate deductions from the data which he collects, and knowing him personally as I do, I know him to be very painstaking and careful in collecting data. If the owners of most isolated plants would take the trouble of putting on integrade watt meters and finding out actually what their consumption is, and divide that into the total operating cost and fixed charges, they would get a very much better idea of what their power was costing them per K. W. It is very common to make the assumption that if you have a 200 h.p. engine, you are getting 200 h. p., and you divide your total cost by 200 h.p., and you say it is costing say $25.00, or whatever it may be, per h.p. per year, for a 10-hour service.

Mr. J. J. Wright: Regardless of the load.

Mr. Black: Regardless of the load. That is where most people make mistakes. On the face of it, it seems funny that a central station which is operated by steam coal, can supply power two or three miles away cheaper than a man can make it himself. Any prospective power consumer who casually looks at it would say 'it is good common sense that I can make that power just as cheap as you can. You may get a little reduction in the price of coal, but you have got your line and all that to keep up, which is very expensive.' They do not realize the great difference there is in running a large plant, compared with a small one. There are some very valuable figures on this subject published in the Electrical News, November, 1903. This article, by Mr. Wm. O. Webster, gives the cost of operating various sizes of engines, and any person who is interested in this matter will get very valuable data from glancing at this table. Speaking from memory, I think this table shows that the cost of running a 2,000 h.p. engine, fully loaded, is in the neighborhood of $20.00 per h.p. per year on a ten hour basis, whereas running a 50 h.p. engine, it may be run up to $70.00 or even $100.00 per h.p. The mistake a great many people make is that they get hold of figures which have been given for large plants, and they assume that small plants can be run as economically. Another mistake which I think is commonly made in all isolated plants is that they make a test right at the start and assume that the plant remains in the same good condition as it was when installed by the manufacturer, whereas in two or three months after it has been in the hands of an ordinary man, who may or may not know very much about it, the cylinders and the valves may be entirely different. Except the engineer knows enough to put an indicator on his engines, say once a month, frequently the valves gets a little out of adjustment, and the coal consumption may be very different than when the plant was installed. The ordinary man who owns a plant has no check on it. He has to depend on the man in his employ, and not being a practical man, he is not capable of judging whether that man really knows his business or not. Another great drawback to these small plants is that the employer is entirely dependent upon the man operating his plant. He has one man, and he depends entirely on that man. Should this man fall sick, or go on strike, he is in trouble at once, and he has to pick up the first man that comes along, whereas by buying power from the central station, he has the full resources of the central men, who are composed of men ready and willing to give him satisfaction at once. Another thing—he has a big company that he can fall back on, and consequently get his power fixed at once.

Mr. Wickens: There is another factor to be taken into consideration. It is a considerable factor in keeping down the cost of the small isolated plant if it is properly installed. Of course, we have had a lot of very badly installed small isolated plants, and in that case there would be trouble, but there are some isolated plants that have been doing fairly well as far as cost is concerned. Where the whole matter is studied out, and the requirements followed, it should not be hard to repeat what the station man is doing for himself. I don't mean to say that we are going to be entirely as one on this question, because the central station men have 24 hours load, whereas the small plant have got to have a double staff, but do not have a good load for more than a few hours, and it becomes troublesome for a little isolated plant to run 24 hours every day. If you are only going to run ten or twelve hours a day, and utilize seven months in the year all your exhaust steam for a good purpose, and have your plant well arranged as to its capacity in proportion to its load, why you can reasonably hold your own against the ordinary central station people. If you go further, and run 24 hours a day, you have got to double up your help, and the cost finally gets so that you could get your power cheaper from the central station. Now, one of the points in connection with the isolated plants in these places is the fact that you have got very good control of the current while you need it, and there is always some place that can be turned off a little during the peak load, and a man, by manipulating it properly, should undoubtedly get a very fair result. However, I think there are places where the central station men have it all their own way, and I think there are places where the isolated plant man has it in his favor.

Mr. A. A. Wright: Now, gentlemen, we have heard from both sides. Is there anybody else who can give us any information—any practical points? We have heard from the isolated plant man and from the central station man.

Mr. York: I am identified altogether with isolated plants, and I think we put in the first isolated plant in Montreal. I am glad to notice by the paper that there are some conditions in which isolated plants can be run to advantage. I think that it is proven that there are a great many of such cases, even more than what the

lighting companies are willing to concede. I draw that conclusion from the great number of isolated plants that are being installed from year to year. All the owners of isolated plants are not making mistakes, surely. We must give these men credit for having some financial ability, if they have no electrical or other engineering knowledge. They look at it from the dollars and cents side of the question. They are not interested as to how much technical knowledge their engineer has, or where he comes from, but it is the amount of money that they have to pay out at the end of the year, expressed in dollars per ton of output of the works, or per yard of cloth, or per hundred pairs of shoes, as the case may be. A good many owners of factories do it that way. In one case that I have in mind just now, a company was advised that it would be a good thing to install a plant, and, so as to make sure that their advisor was advising them correctly, they adopted a method of this kind. They borrowed money from a certain fund they had for loan purposes and put in a plant costing about $6,000, and they also put in the necessary watt meters and so on. At the end of every month, they had the engineer render them an account for lighting, and then they paid the amount, that is, they paid into themselves the surplus or excess that it cost them to run the engineer's department, as compared with the corresponding month of the previous year. What was left over, they set aside to repay the money borrowed from this other fund, and by so doing, in something like two years and seven months, they repaid the entire cost of that installation, so that might be taken perhaps as a very favorable instance, and one where they left out the technical question as to how much it cost them per k.w. It was how much they would have to pay out this year and how much next year. I have another case in view here, in favor of an isolated plant in this city, where they installed a good many years ago what was then considered a modern plant, and some years later it was shut down, and they purchased their light from the lighting company. It remained closed down for, I think, six or seven years, and this year they have cancelled their lighting contracts and also scrapped the entire original plant, and installed a brand new one of equal capacity. Now, we must give these men credit for being able to figure out in dollars and cents what they are doing, so that on the whole I am sure the isolated plant has come to stay, and not in a few isolated cases, but in the great majority of cases, it will be found that the isolated plant will pay. Its particular advantage, of course, is in the use of exhaust steam in winter time. That is certainly a great advantage. As to the advantages mentioned by Mr. Black of having a very large corporation to fall back on, that, in my mind, is somewhat of a disadvantage, because if you have a small firm to go up against, and their is competition in the field, why you have a chance of dealing with them, but if it is a very great corporation, and they haven't any competition, then they simply talk nice to you, and that is all you get for it. (Laughter). Then, again, I can see why lighting companies, especially in this section of the country, are not very strongly opposed to isolated plants; it is because they have all the business they are able to handle at the present time, and at increased rates as well, so that, I think, would be sufficient reason why the companies here are not so antagonistic to the isolated plant as they otherwise might be if they were in competition for rates ; so taking these things into consideration, I firmly believe that isolated plants will go on increasing and that there is even a still greater future for them.

Mr. Kelsch : I have listened to the remarks on this question of isolated plants. For a number of years I was connected with a large operating company who have made a special effort to remove all isolated plants in the city in which the company is operating. The company is now operating an isolated plant of 6000 k. w. capacity. This is a very large plant, nevertheless the firm receiving this power considers it cheaper to purchase it than own their own plant. While connected with that company, I had occasion to look into the cost of isolated plants, and there are a good many items that are never charged to the cost of operating isolated plants. In making up an estimate on one occasion, I found a large sum of money charged to legal and damage account. It amounted to over two thousand dollars and was a very large item on a small plant. It was in a D. C. plant where a man was accidentally killed and the two thousand dollars was charged to legal and damage account, instead of being charged to the cost of operating the plant. I did not expect to be here to-day to discuss this matter, but if I had thought of it, would have made a note of a large number of items that in ninety-nine cases out of a hundred, are not charged to the cost of operating isolated plants. I remember on one occasion, we went into a building to make up an estimate on the cost of operating an isolated plant, and on this occasion found that the plant occupied a space of 1500 square feet of very valuable floor space. The business of the firm was increasing and they were obliged to rent an adjoining building. In making up the cost of operating this isolated plant, we found that the additional building which the firm was obliged to rent was not charged to the cost of operating the steam plant, but charged to the regular rent account, while as a matter of fact, the space occupied by their isolated plant made it necessary to rent the adjoining building. During the holiday season, when many concerns are obliged to operate to their full capacity, and running overtime, the plant not being built for such a strain, is often overtaxed. There are many additional expenses at these times which we have found were not charged to the cost of operating the plant, such as extra meals for firemen and engineers, necessary to run overtime, etc. We have frequently found that where the regular force was incapacitated, the time of extra help was not charged to the cost of operating the plant. It is easy to find many other items never included by the owner of an isolated plant. Depreciation and repairs are seldom charged against the cost of producing light and power. On some occasions, we find that depreciation was allowed at the low rate of one and two per cent., whereas depreciation due to antiquasion, as well as the plant being outgrown, by the increase in business, very often makes the depreciation nearer twenty per cent. than two per cent. The average isolated plant, say, for example, has a 150 horse power engine, and it will be found that such plants have a load factor ranging all the way from ten to twenty-five per cent., which means poor economy. It has been remarked that an isolated plant has the advantage of the owner having control of the plant all the time. I think power from the central station is far better in this respect, for as a general rule it will be found that the owner of an isolated plant cannot use it outside of regular hours without preparing for such use during the day and at considerable extra cost, such as overtime for the employees, etc. My office here in Montreal is in a building having an isolated plant. If I arrive at my office half an hour early in the morning, I am obliged to ride up in an elevator that is dark almost to the danger point, due to the fact that the isolated plant which is supposed to be under the control of the owner is not ready to run. If I have occasion to be in my office in the evening, I have to burn a candle. I do not mean to say that there never was an isolated plant that did not pay. There are under certain conditions where a large amount of steam or heat is required, isolated plants that pay fairly well, and I think Mr. York, who has just described the method of his company in deciding on an isolated plant, has a successful isolated plant, due no doubt to the fact that they employ practically no more help to operate the same, outside of possibly an engineer, as they are large users of steam and heat.

The President : Now, is there any one else ? Mr. Wright, you ought to be able to give some information.

Mr. J. J. Wright : Well, Mr. President, I can only speak from a slight experience. During the past year

or two the isolated plant craze struck Toronto, and quite a few isolated plants were put in. I can only say that they are coming back one by one. I think that about ninety-nine are safely in the fold, and there is only one on the "hills far away." The last one to come back to us is an isolated plant that was put in on certain representations of the wonders it was going to perform, and it is a first class plant in every respect, thoroughly up-to-date, and in a first class location for manufacturing purposes, but the latest information I have is that our company has closed a contract to supply that company with power for five years. (Applause).

Mr. Higman: This paper does not deal specifically with electric lighting, but comes sufficiently near the subject to admit of the presentation of a few statistics on the condition of electric lighting in the State of Massachusetts. I had the opportunity a short time ago of reading the report of the Board of Light Commissioners for that State and gleaned from it the following facts. Of the total number of plants considered 21 are under municipal control and 82 under private enterprise. In 1904 the total income of the 103 systems was $7,663,961, and after deducting all expenses including interest and depreciation there was a deficit of $465,422. One of the private companies did not earn sufficient to pay working expenses; some companies were unable to pay any dividends, while others paid dividends varying from 2 to 10 per cent. The total capital invested in municipal plants is about $3,000,000 and the total assets of the private companies amounts to about $30,000,000. There was a direct loss of $85,055 on the municipal plants during the year, but to this must be added $61,725 for interest and $85,841 for depreciation, making a total loss on the year's operations for the municipal plants of $232,631. I am speaking from memory, but I think the figures given will be found to be substantially correct. As tax-payers it is well that we should consider, very seriously, what the prospects are of earning dividends or even meeting working expenses on investments of this nature.

The President: I do not wish it to be understood, nor would I like anyone to understand, that I make the assertion that the isolated plant under no circumstances will pay, as there are exceptional cases, of course, as we all know, where an isolated plant is all right, but taking the large proportion of them, I think it will be found that energy from the central station can compete with them quite easily.

Mr. Black: Mr. York, in his remarks, says that while the business men may not be engineers of ability, they are masters of finance. I have in mind a bank building where they have installed a large isolated plant. The bank has a general manager who is drawing a salary of probably $25,000 a year, and a local manager who is drawing a salary of say $10,000 a year, and several other highly paid men. These men might be called captains of finance. At the same time they have installed an isolated plant which should never have gone into the building. As far as I can find out, the only data that they have got on this matter was to ask the architects whether they were to put in a plant or not. They put in an isolated plant to run an elevator which probably does not run more than once or twice an hour, and also do a little lighting. We all know the banking men do not stay at their offices as late as we electrical men do, so they do not use very much artificial light, and the plant has to run all day just to run an elevator. I am quite sure that the local supply company could supply current to be used in a legitimate way for less than half the cost, not to speak of the amount of capital invested which should be charged against that plant for floor space, smoke stack, and so forth. Mr. York also referred to the fact that central station men were not very much opposed to isolated plants; in a great many cases they are not; the isolated plants are really a help to the supply companies. The business is growing in a great many cities so much that it is hard for the companies to keep up with the business. Another point—the isolated plant is a splendid advertiser for the other companies. The people who own the plant use light recklessly, as they think it does not cost them anything, which is a splendid advertisement for the supply people. For instance, take a departmental store on the main street which I have in mind at present. This store and the adjacent stores are a regular blaze of light, simply because the plant in their basement "does not cost them anything." The neighboring stores get their lights from the supply companies, and consequently have to burn more to keep up with their ill-advised neighbors. In that way the isolated plant is a great help to the supply company. I know of an isolated plant in a departmental store where they do this. The departmental store is six or eight stories high, the front being almost all glass, and they own several of the adjacent stores, which they rent. With the rent they give the electric light free, simply because "it does not cost them anything." In one case they objected to one of their tenants burning 16 c.p. lamps, and they made him put in 32 c.p., simply because it gave a better appearance to the place, and "they had to run their plant anyway," so that in a great many cases isolated plants are a good help to the supply company.

Mr. Burran: Mr. York mentioned that in a place where they have to have an engine and boilers for their purposes, that an isolated plant would pay in almost every case, I think he said, if not in every case. I have in mind a hotel that a year or so ago was in a similar position—they had to have an engineer and fireman, and boilers, and that sort of thing. They had been running from a central station for a few years, and consequently knew very well what the cost was. They had an elevator that had to run all day, and they also had something like seven or eight hundred lamps, so it was not a very small thing. They were persuaded to put in an engine and generator, and were told they would save a large amount of money, because they could utilize the exhaust steam not only in winter time for heating, but in summer time for cooking, and further other purposes, so they got their plant, and in about four months they spent for coal and a few things of that kind all that they had paid the previous year for their lighting and elevator service. It was only about a month after that when their dynamo was on the market, and the plant sold.

Mr. Campbell: I am pleased at having had the opportunity of reading a paper which has brought out so much discussion this morning. It seems to me that this discussion has been wanting in the past few days. But this is a subject that seems to have struck them in the proper mood, and it certainly is a very interesting discussion. I am sure if Mr. Aitken, the author of the paper, were here, that he would have been delighted to have heard the discussion that has taken place over it this morning.

Mr. A. A. Wright: I would like to move that the thanks of the convention be forwarded to Mr. Aitken for his paper, and I am very happy to be able to endorse, so far as my experience has gone, everything that he has said in the paper.

Mr. York: I take great pleasure in seconding this motion. Carried unanimously.

The President: We have another paper this morning written by Mr. McKay on "Steam Engines and Boilers." I understand that as Mr. McKay is unable to be present, one of the gentlemen will kindly consent to read the paper.

Mr. Wickens read Mr. McKay's paper.

The President: We are very much indebted to Mr. Wickens for reading Mr. McKay's paper. I hope there will be some discussion on this subject. Before going on with the discussion, I might say that I hope that the members of the Executive who are present will wait for a few minutes after this meeting. This afternoon there will be the matter of the election of officers to take up, and also a few of the questions in the Question Box.

Mr. York: I do not think there is very much to say

in regard to this paper. It is certainly very instructive, and should be kept on file. There are some very good points contained in it, although there are one or two little points that the writer evidently overlooked, that is, in reference to the careful firing part of it. My experience has been that if you want to get the best economy from coal, you must leave the fireman out of the question. If you are going to depend on the fireman, you are not going to get what you are looking for, that is, in the majority of cases. If your furnace is so wide that he can keep up steam with holes in the fire, that is the way he is going to do it. It will be easier for him. If the steam does not come down, he will not worry about what is going on in the furnace. If you have a variable load at different times, it would pay in a great many cases to have two boilers. The average fireman will not try to save the coal—you can get some few who will, and in large establishments especially I think the better way is to leave any economy, as far as the fireman is concerned, out of the question. That has been my experience.

Mr. Wickens: Mr. McKay starts out in a very good way, because the first statement that he makes is that we have got to look to the boiler, and it is no use splitting hairs about the engine—that our boilers are perhaps the wasteful source in so far as the use of steam is concerned. Of course, there is another point in connection with steam plants. They do not take care of their boilers. The difference between a dirty and a clean boiler is very marked. Then, as far as cleanliness is concerned, there is nothing so bad for a boiler as an accumulation of oil inside of a boiler shell. By experiments that have been conducted along that line by some very eminent engineers like C. Y. Williams, D. K. Clark, and some of those gentlemen, they proved conclusively that oil is perhaps the worst conductor we have. The difference between the heat of the sheet on the fire side, and upon the water side, if the boiler were perfectly clean, was about 79 degrees. When they put the very finest film of oil on the water side of the sheet and then fired it up, the difference between the heat of the sheet on the two sides was 190 degrees. As they thickened the oil slightly, it went up to nearly 300 degrees and finally it got into such a heat that the sheet was beginning to show signs of being burnt; in that case it would not be long before the bottom was burned out of the boiler. This was in an experimental boiler, and it only goes to show that there is a very large amount of waste by not having the boilers clean.

Mr. A. A. Wright: I would like to ask Mr. Wickens how the oil gets into a boiler under ordinary circumstances.

Mr. Wickens: In the first place, if you are using your water from a condenser, your exhaust steam carries the cylinder oil with it, and it gets into the hot well through the air pump. Of course, you may say we will make a well four or five feet deep, and we will run our pipe away down, and we will not get any oil in that way, but the water would be perhaps 150 degrees hot, this much cooler than the steam. Steam just carries the oil into that water in the form of spray, which strikes the cooler water, this collects the oil again, and the feed water pipe is sure to take oil and water alike and deliver all to the boiler.

Mr. H. W. Weller: I, unfortunately, have just arrived, and did not hear Mr. McKay's paper read, but I had a copy of it, and I looked it over, and I find one or two little things that we should certainly take exception to. Of course, it seems hardly courteous to criticize the paper when a man has taken a great deal of trouble and pains and care in writing it for the benefit of the Association, but as I think you are all in search of information, you do not wish to be misled unless you are misled with your eyes open, and that must be my apology for making a few remarks. First of all I notice that Mr. McKay takes the stand that no boiler should have more than 35 square feet of grate surface. Well, of course that is all right, provided the manufacturer of the boiler is limited by his special features of design to that grate surface, and possibly that may have a little to do with Mr. McKay's remarks; but I would make this statement, that in all plants, or in 75% of plants of say 500 h.p. and upwards that are to-day operating, a great many installed by engineers of very high repute, you will find that the average grate surface is from 60 to 80 square feet, using the larger boiler units, and I think that this latter is nearer the correct size when you get into larger plants of two thousand horse power and upwards. For instance, you take a plant of two 250-h. p. boilers, they each have between fifty and sixty square feet of grate surface. I do not think that there is any difficulty, even with the ordinary class of fireman, in covering a grate of even eighty square feet if necessary, and cover it evenly, so that you will not be troubled with cold air getting through. Of course, with regard to the question of internal fired boilers, this is rather a tender subject to touch upon, especially standing, as I do, as the representative of Babcock & Wilcox, Limited, probably the largest boilers manufacturers in the world. We claim, of course, that a brick set boiler is the thing, and of course we have reasons for thinking so, outside of the fact that we are exploiting that particular boiler. We think that in the internally fired boiler there are several serious objections, especially for electric plants. In electric plants, where the fluctuation of load is quite considerable, it is necessary to have what we call a quick steaming boiler, a boiler which you can force readily from half load to full load, or even 50% over load, with the least possible delay. Now, I know that you cannot do this with an internally fired boiler, and I consider that it is very dangerous, even if you could do so, on account of the expansion and contraction not being properly provided for. That is a fact that I think is known to most engineers. As regards the economy between an internally fired boiler and a brick set boiler, that is, of course, a point on which a good many engineers, I presume, differ. If you are going to run a plant for five or six hours, and then shut it down, and let it cool off altogether, there is a certain amount of objection to a brick set boiler, but that is not the condition that we meet with in everyday practice. Brick setting, of course, will absorb some of the heat at first, but after you have got it heated up, you get far better combustion, and consequently better economy. I might mention that quite recently there has been a very careful series of tests made by authorities which I think no one will question, and that is the British Admiralty. They have made a series of tests quite recently on four battleships, all identically similar except in the boiler equipment. There has always been a feeling amongst some of the older engineers in the navy that for certain conditions the internally fired or Scotch marine type is preferable, especially, as they claimed, for steaming at ordinary cruising speeds; consequently in the last four battleships, they installed, in the first one (I think it is the King Edward VII), two-fifths of cylindrical boilers and three-fifths of Babcock boilers which are essentially brick set as regards the furnace, even in the marine type. In the second ship (I think The Dominion), they installed one-fifth of cylindrical boilers and four-fifths of Babcocks with the brick set furnace. In the other two that were last completed they are all Babcock boilers. They have made a very careful series of tests, extending over many weeks, taking the actual amount of fuel per indicated horse power on the engines, operating at different speeds, at one-half, three-quarter and full speed, and in every case it showed that the fewer of the internally fired boilers that they had on the ship, and the more brick set furnace Babcock boilers they had, the higher the economy they obtained. These figures are on record, and can be seen by any of the members who wish to do so. I do not know that there is anything further that I can say, and I hope you will pardon me for having taken up your time in making this statement, and I am sure that you will do so on

account of the fact that we are all here in search of information.

Mr. Farmer: Mr. Chairman, I should like to endorse to some extent the remarks made by Mr. York in regard to the fireman, and his bearing on the economy of firing a boiler, and the particular remark which struck me was this—that it is not always fair to charge to the fireman the falling off in efficiency which occurs when making a test on a boiler. I think that it often happens that the fireman is unable to get the economy out of a boiler that he would if the conditions were better planned for him, and of course the condition which can be pre-arranged and very greatly bears on the efficiency on a boiler, is the amount of grate surface provided, and this is a difficult subject to approach on account of the difficulty of obtaining exact information on the subject. Of course, there are two errors that can be made, one by giving too little grate surface, usually in making the grate too narrow, when you have to put on too large a force of draft in order to get the necessary rate of combustion, at a higher rate of combustion per square foot. The difficulty in maintaining the high pressure is that it dislodges the coal, and the fire from that cause burns unevenly. On the other hand, if you have too great grate surface, it is difficult to keep the draft down to a sufficiently low point. The coal burns away too rapidly. The pressure of the amount of steam generated is temporarily above the normal, and the fire has to be allowed to burn down to a certain point or else you would be making more steam than is required. Again, loss in firing is due to heating more air than is actually required for combustion. There are lots of tables illustrating this point, and it is very striking when a comparatively small increase in the amount of air used in combustion occurs, what a large amount of heat is wasted from that cause. Now, it may be interesting to give some concrete figures on this point. I have had the opportunity of making a considerable number of tests on boilers in various parts of the country in the last few years and the results of course are very variable, and make it very difficult to get down to any final conclusion, but I should like to mention one test particularly, made at the Manhattan Elevated Railway plant at 74th street, New York. That plant is equipped with Babcock & Wilcox boilers, of I think 525 h. p. each, and they are so arranged that the coal has to be burned on the grates at the rate of approximately 20 pounds per square foot of grate surface. I mention this Manhattan Elevated test for the reason that that was the lowest amount of air that I found, with one exception, in a plant working under the ordinary commercial conditions. The amount of air taken was a little under 20 pounds of air for a pound of coal. There has to be a certain amount for dilution over the twelve pounds theoretically necessary, but you will find that the amount in an average plant varies anywhere from 24 up to 40 or even 50 pounds, so in that way 20 pounds of air may be taken as a very good working condition. The coal used on that occasion was a semi-bituminous, procured from Pennsylvania. On the whole, my opinion would be, and I think it would be endorsed by most practical boiler men, that it is well if anything to err on the side of giving too much rather than too little grate surface. It is easier to maintain economical results when you have a little excess surface to go upon, rather than when you have a limited surface.

Mr. Wickens: I think Mr. McKay refers to the amount of grate surface for a 100 h.p. boiler, which means 35 square feet for 100 h.p.

Mr. Weller: That is entirely too much—35 square feet is too much for a 100 h.p. boiler.

Mr. Wickens: I have in many different cases seen boilers with eighty and ninety square feet of grate surface on them.

Mr. J. J. Wright: Perhaps there is a little misapprehension in this matter. I think that Mr. McKay referred to single fire door, and 35 square feet of grate surface, five feet wide and seven feet long, as he states it, as the limit of reasonable firing.

Mr. Weller: I think what made Mr. McKay give that figure five feet wide, is that the five foot wide furnace is the largest they can put in their boilers, if I am not mistaken. Of course, it is really a question of doors as regards the width. Now, I will agree with Mr. McKay as regards the length, as seven feet is about the limit that a man can cover properly from the front without using automatic stokers, but as regards the width it is simply a question of fire doors. On the wide boilers we make, our practice is to ometimes put four fire doors, usually a fire door for about every three or four feet of width in the furnace.

Mr. Black: In the absence of Mr. McKay, I think that as Chairman of the Paper Committee, I can throw some light on this point. The Executive have been criticized in the past for getting papers that were too difficult for the average central station man, and the Executive instructed the Paper Committee to try and get papers which would interest the small central station man, and this paper which Mr. McKay wrote for us was written from notes which I supplied him, and in these notes I asked Mr. McKay to give information on boilers and engines which would help them to install a small plant. I made a note about installing a plant of 100, 200 and 300 h.p. and asked him if he would put in one, two or three boilers and whether they would be return tubular or water tube type, and also asked him to discuss in the paper how this would affect the first cost and operating cost, and I think possibly that is what Mr. McKay has referred to, and that I limited him more or less to small plants.

Mr. Wickens: I move that a vote of thanks be tendered to Mr. McKay for his paper.

Mr. Reesor: I have much pleasure in seconding that motion. (Carried unanimously).

Mr. Reesor gave notice that he would move at the next session of the Association to amend the constitution, by admitting to membership all those engaged in the electrical business. This was seconded by Mr. J. J. Wright.

Upon motion of Mr. Black, resolutions were unanimously adopted tendering the thanks of the Association to the following:

To Mr. H. D. Bayne and members of the Local Committee, for the very complete arrangements made for the comfort and pleasure of the members while in attendance at the Convention.

To the Secretary of the Canadian Society of Civil Engineers for their kindness in placing at the disposal of the Association their well appointed quarters in which to hold the business sessions of the Convention.

To the Allis-Chalmers-Bullock Company for kind hospitalities extended to the members while in attendance at the Convention.

To the Montreal Light, Heat & Power Company for courtesies extended to the members while in attendance at the Convention.

To the Montreal Street Railway Company for kind courtesy in giving free transportation to members over their lines during the Convention, and for the conveniently arranged books of tickets prepared for the use of members.

To the authors of papers for the able and instructive papers prepared and presented at the Convention.

To the Secretary of the Engineer's Club for courtesies extended to the members while in attendance at the Convention.

To Mr. A. A. Dion for the valuable work which he performed during the last two years as editor of the Question Box.

The Convention then adjourned until the afternoon.

FRIDAY AFTERNOON SESSION.

The President: Before we proceed to the election of office bearers, I think we should first have some expressions of opinion, and eventually a vote, on the place of next meeting. I do not know if there is any particular way in which we should take that discussion up, but it is one of the things that we have to decide upon this afternoon, and as I understand we have one or two invitations, I would ask the Secretary to read

these, and then I would like to hear from the members as to what place they personally consider the most suitable for the next meeting, and then we can vote on the matter.

The Secretary thereupon read a telegram from the President and Secretary of the Halifax Board of Trade, inviting the Association to hold their next annual convention in that city, and also a letter from Mr. G. A. Powell, of Winnipeg, stating that the matter of holding the convention in the West had been considered to some extent, but that nothing definite had been arrived at.

The President : I might mention, before going on with the business before us, that the Forest Wireless Telegraph Company extend an invitation to any of the members who can visit their offices in the Coristine Building. This invitation is extended by Mr. Hughes, their electrical engineer. Is there any suggestion now from any of the members as to the location for next meeting. I have heard several expressions of opinion of suitable places from Halifax to Vancouver.

Mr. Williams: I would suggest Niagara Falls as being a very suitable place for next year's meeting, on account of the immense electrical developments that will be finished by that time. I am sure it will draw a large number of members.

Mr. A. A. Wright : Mr. Chairman, is there anyone present from Halifax who could give us any reliable information about that city. It is certainly very desirable that we should in the very near future go to Halifax, and in the not very far distant future go to Winnipeg. Just now it is the dog that wags the tail, but it will not be many years when it will be the tail that is wagging the dog. I would like to ask if there are any electrical plants in that city, and if there are any in Newfoundland, and how much it would cost to go from here (we would have to have a Pullman car, I suppose), and how long it would take. It is very desirable to go to Halifax—there is no doubt about that. If we can do any missionary work by going east, I would like to go. Still, I would not like to jeopardize the working of the Association.

The President : Mr. Starr, of Halifax, might be able to give us some information.

Mr. Starr : Mr. President, I regret that there are no station men from Halifax present at the meeting, or, in fact, from the Maritime Provinces, and that in itself, I think, would be a very good reason why the Association should go to Halifax. At the last Convention in Hamilton, there was one station man from the district east of Quebec. At the previous Convention in Toronto, there was only one. One advantage for the Convention to meet in Halifax would be that it would bring in without doubt a number of members, and in after years these members would attend the Conventions held in this part of the country. In reply to Mr. Wright's enquiry as to the plants in the Maritime Provinces, I might say that in addition to a number of others, there are large plants in Halifax and St. John, and, as you are probably aware, there is a very large plant at Sydney—that of the Dominion Iron and Steel Company—one of the largest in the Province, and I think I am safe in saying one of the largest of the kind in the Dominion. That could be reached from Halifax as a side trip, and, of course, at the same time you would have a glance at Cape Breton and the coal district. As to the cost, I think that would be very much less than going to Winnipeg. The Intercolonial Railway would give return fare on certificates for one fare. The single fare from Halifax to Montreal is $16.50, exclusive of Pullman. The Pullman fare is $4.00 from Halifax to Montreal. I think it would be a very good move on the part of the Association to go to Halifax, and while I am not asking to have any particular date set for the meeting, if it could be arranged to have the meeting in September, the Dominion Exhibition will be held in Halifax next year and it might be well to hold the Convention at the same time. Of course, I do not know whether that meets with approval, but I certainly think it would be a very good idea, and would tend to increase the membership of the Association, and in after years the members would come up here, whereas at the present time they have no representation at all. As far as the social end of the affair is concerned, I can assure the members they would be well taken care of.

The President : My own personal opinion is that the majority of central station men hate to be away in September. They are beginning to get ready for their fall load in September, and generally speaking you have a great rush to get through with your preparations to take care of your fall load. I do not know if that is the experience elsewhere. It is usually my own experience. Many of us consider that the most suitable time is like the present, in June, when you are not worried about taking care of fall loads.

Mr. Pilcher : I fully endorse what Mr. Starr has said in reference to Halifax, and it has also occurred to me that at Conventions of this kind, while it is true we all like to visit the large installations that have been put in from time to time, I believe if you go to Halifax you will get down to business, and there will be a little more business done at the meetings by leaving these side trips out. I am sure, if we have one meeting in the Maritime Provinces, we will get at least 25 members the first year. It is out of the question to go to Sydney, because it will take another 12 hours. I was rather amazed when Mr. Wright spoke—I hope the members will excuse me for rubbing it in—but there is a gentleman representing a section of the Dominion, and he does not know anything about the Maritime Provinces. That is why I say come down and see it.

Mr. Higman : The Civil Engineers went down to the Maritime Provinces and other points, and they found it the most enjoyable trip of their whole experience. They were fortunate enough, however, to secure free transportation.

Mr. Pilcher : Really, I believe the Intercolonial Railway Company are so anxious to have people go down there that we would get very liberal discounts from them. I simply give it as my own experience, and I feel quite sure that if the Association approached the Intercolonial Railway, they would be very kind to us indeed.

The Secretary : It might be interesting if Mr. Pilcher or Mr. Starr would give us some idea of the probable local attendance at such a convention. Of course, we might naturally expect that the attendance from the west would be much smaller at a meeting in Halifax than it would be in Montreal or Ottawa, or the West, and it would be interesting to know how many would be likely to attend from the Maritime Provinces.

Mr. Pilcher : Judging from my own personal experience of the people down there, and the interest taken in electrical matters, I think that we would get at least twenty-five station representatives. I do not know whether that is right or not. Mr. Starr and Mr. Rough know the people even better than I do, but I think I am quite safe in saying twenty-five.

The President : Are there any other expressions of opinion. Will anybody make a definite motion?

Mr. Bucke : I think it would be rather interesting to find out from those here at the present time how many would go down to the Maritime Provinces in case the next Convention was held there. Twenty-five is a small number for a convention, and I do not think anything like that number would go down. I would be very much in favor of Mr. Williams' suggestion to go to Niagara Falls. They have got three big power companies there, and two of them at least will be operating next year, and probably three. They are putting up a new hotel at the present time, and there will be splendid accommodation. Some of the members have suggested that we hold a meeting of the Association in transit. We could charter a boat and have a meeting on the boat. You can do anything you like from Niagara Falls—you can go over to Toronto or Buffalo, and there are all kinds of things to

do from that point. I think Mr. Williams' suggestion is the better one.

Mr. A. A. Wright: Well, now, Mr. Chairman, is it necessary that this thing should be decided to-day? How would it do (if we put it off for another day), for your humble servant to interview the Minister of Railways, and see what he will do for us. Being one of his good supporters, I might have perhaps a little more power than some others, and we could find out definitely what he can do for us, and see if it would not be possible for us to go down. I would be willing, as Artimus Ward says, " to exert my ability in that direction."

The President: I believe by Article XIV of the constitution, the next place of meeting is selected at the annual meeting.

Mr. A. A. Wright: That lets me out.

Mr. Williams: I move that the next meeting be held at Niagara. I know if you go down to Halifax, I for one could not spare the time to go.

Mr. Purcell: I would like to second that motion. I think that the trend of traffic is towards the west, and with another meeting in Ontario, it might be advisable for us to meet in Winnipeg the next year.

Mr. Hamilton: It seems to me that the Association can hardly afford to take a selfish view point in considering this matter. The Association is broad in its intentions and scope, and should take in all the station men in Canada. Those on the Pacific Coast are pretty much out of reach, but certainly the Maritime Province men are not, and they should be given a chance to get some ot the benefits of membership. Now, the National Electric Light Association has its meetings all over the United States, and those who cannot go one year are able to go the next, and in that way they all get some benefit, but as it is here, it would appear to be the object of some to keep it in the western part of Quebec, or in Ontario. It seems to me that the matter should be looked at in a broad way, and if possible things should be so planned that a little wider scope can be given, and membership can be secured from a wider territory. (Hear, hear).

Mr. Purcel: How many members, I might ask, are there in the maritime Provinces, and in the western provinces, not including Ontario?

The Secretary: If you mean east of Montreal, and west of the Soo, I could not say, but they would be very, very few; perhaps twenty would cover it.

Mr. Hamilton: Why should there be many? They have never had any inducement.

Mr. Pilcher: The discussion seems to be on the principle that Nova Scotia only wants a convention once in fifteen years. That is about all.

Mr. Macfarlane: I move that the Association meet in Halifax next year.

Mr. A. A. Wright: I second that motion, because I do not think we will go there. I am bound to be on the winning side any way, but really I think that if we do not go there this next year we might next. I am very glad it has been brought to the notice of the meeting, because I think we ought to try and go there at least the year after, and I think in the meantime we should get all the information we can, and see what we can do by going there. We must not be too selfish in this work. There are many respectable people living down in the Maritime Provinces, and we might like to go and see them. I would like to say another thing, and that is that we invariably pick out the big hotels for all the station men to go to—at least we all go there. Now, we are not all millionaires in this world, and if we continue in the electrical business I don't think we shall ever be, so I think we should pick out accommodation at some moderate price respectable hotel, where any man can go, and have our meetings in the very best place we can. It is not necessary for us to put on airs.

Mr. Williams: I do not think that the Association selected any particular hotel in Montreal.

The President: As far as the arrangements in Montreal were concerned, I practically made them myself, and I purposely left the hotels out, as I felt that some of the members might want to please themselves in this respect. I went to the Windsor Hotel and tried to arrange special rates, but they were not too anxious to receive us, and rather than make any distinction, I thought it would be best to make headquarters at the Canadian Society of Civil Engineers' rooms.

Mr. A. A. Wright: I might say, Mr. Chairman, that I did notice that, and I was very glad to see that you did so. Still, notwithstanding that, we must understand that our Secretary was there, and the room was there where we got our vouchers, and although it was not said so in so many words, yet we could read it between the lines.

Mr. Black: It seems to me that the Convention has been a great success (hear, hear), simply because we have come to a place which is more or less central. If we hold our meetings at places where we will get a large local following, it keeps the prestige of the association up, and that we cannot afford to lose. At the next Convention, instead of having 320, as at this convention, I think we should have at least 400. Now, from an economical point of view, it seems to me that it would be better for the Association to keep the convention in a central place, where the majority of the member could be present. I sympathize with the members, and those who are interested in the electrical business, who live outside of the central portion. It is certainly a drawback to them not having a convention that they can easily reach, but if we can do somebhing so as to defray their expenses, that should overcome the difficulty.

Mr. Starr: I would like to correct an impression made by the last speaker, Mr. Black, in suggesting that the Association might defray the expenses of those too far away from the place where the convention is to be held. It is more owing to the fact that the benefits of the Association are not known to the central station men down there, and that is one reason, if the convention went down there, and induced these men to join, they wonld be glad to come up here in future.

The President: I will have to bring the matter to a head now, so if anybody has anything to say in the matter, I wish they would say so. We will have to put the question box before the meeting after.

Mr. Black: Is everybody entitled to vote on this?

The President: According to the constitution the only people that are supposed to vote are the active members, but still that does not prevent the associate members from giving a general expression of opinion, which I am sure would influence the active members.

The matter was then put to a vote, the method adopted being by a show of hands. Five voted in favor of holding the next convention at Halifax, and the remainder in favor of Niagara Falls.

The President: I think we will now proceed with the election of office bearers, and it is necessary to appoint two scrutineers. I appoint Mr. Purcell one, and Mr. Fisk the other.

The President then read Article XVII of the constitution.

It was proposed by Mr. Higman, and seconded by Mr. Black, that Mr. A. A. Wright be elected president for the ensuing year. Carried unanimously.

Mr. A. A. Wright: I must say that I certainly thank you most heartily for the gift you have conferred upon me—the highest gift in the hands of the Association. I do not know whether I shall be able to fill the office or not, but if I am to occupy it for the ensuing year, I shall endeavor to fill it to the best of my ability, and I hope that at the next meeting we will have just as good a meeting as we have had this year, and perhaps a little better.

Mr. J. J. Wright: Mr. President, I have great pleasure in nominating Mr. R. G. Black for the office of first vice-president.

Mr. Macfarlane: I have great pleasure in seconding Mr. Wright's motion. (Carried unanimously.)

The President: Now, gentlemen, the second vice-president.

Mr. J. J. Wright: I suppose it is in order for one member to nominate two members. I nominate Mr. John Murphy as second vice-president.

Mr. Higman: It affords me great pleasure to second that motion.

Mr. Black: I have very much pleasure in nominating Mr. C. H. Mortimer for the position of Secretary-Treasurer. Mr. Mortimer is centrally located, and as the convention is to be held next year at Niagara Falls, I think Mr. Mortimer can fill that post better than any one else.

This motion was seconded by Mr. Burran and carried.

Mr. Thornton: Mr. Wright, as you are now President of the Association, you might come up and take the chair.

Mr. A. A. Wright: I have got to go in a few minutes.

Mr. Wright thereupon took the chair, and said: I thank you, gentlemen, for this warm reception.

Mr. Murphy: I would like to take advantage of the temporary absence of our President from the chair, to move a very hearty vote of thanks to him (Mr. Thornton) for the admirable manner in which the arrangements for the convention have been carried out.

This motion was greeted with prolonged applause.

Mr. A. A. Wright (President): I have much pleasure in conveying the hearty clappings of this meeting to yourself, and also to inform you that all these clappings were for you.

Mr. Thornton: I can assure you, gentlemen, that I thank you very heartily for your appreciation of any little work that I may have done. Personally, I may say that it has not been very hard work, because I have been really interested in the work. I have always been interested in the Electrical Association, and have always believed that it is in the interest of the central station men generally to belong to such an association. I have felt for a long time that we ought to get down to serious work, if we want to have the work of the Association kept up to standard. I think that a convention should be a case of hard work for the delegates. I have no doubt that some of the members have found it hard work, but I do not know whether it was altogether from attending the meetings. I thank you very heartily, gentlemen, for the expressions of your good will.

A ballot was then taken for the members of the Executive Committee.

Mr. A. A. Wright (President): I have much pleasure in declaring the following officials our Executive Committee for the ensuing year: Mr. A. A. Dion, Mr. B. F. Reesor, Mr. J. J. Wright, Mr. J. A. Kammerer, and Mr. C. B. Hunt. The next thing is the election of five more, as I understand it.

Mr. J. J. Wright: I would like to suggest that our Secretary send a courteous reply to the Halifax Board of Trade, setting forth the reason why the delegates could not decide in favor of Halifax, and so on, and that certain conditions make it necessary to hold our convention elsewhere.

Mr. A. A. Wright: That is a very good suggestion, Mr. Wright, and I have no doubt the Secretary will act accordingly. There is another matter that we should take into consideration, and that is the gratuitous labor that Mr. Dion has given us in preparing questions for the Question Box, and sending out lists. This is becoming more and more an important feature in our association. It is one of the most advantageous forces that we havé, and I think it is one of the reasons why members are added to the institution. I think some one should say something on this point.

Mr. Thornton: I have very much pleasure in moving that a very special vote of thanks be granted to Mr. Dion, and that the Secretary be instructed to write to him accordingly. We have not had very much time to take up the Question Box as a part of the programme, but I do not think that we can infer from that that the Question Box has been in any way slighted. The discussion this year of all the papers has been very good indeed, very much better than a great many conventions that I have been at, and there are many questions that have come up in the discussion, dealing with matters contained in the Question Box, and many of the questions have been answered in this way. I consider it is a most important part of the Canadian Electrical Association, and it ought to be continued, and Mr. Dion deserves our sincere thanks.

Mr. A. A. Wright: I might suggest that we request Mr. Dion to take charge of the Question Box for another year.

Mr. Thornton: I am afraid he will not do that. He told me that he certainly would not. He has certainly made a success of it. If we can induce him to take it up and carry it on for another year, I think we ought to do so.

Mr. Burran: I have very great pleasure in seconding that. I think Mr. Dion has done a very valuable amount of work. The onus of the work has been on Mr. Dion, and I think he deserves the best thanks of the Association.

Mr. A. A. Wright (President): Is it your wish that it should be carried? (Carried unanimously.)

Mr. A. A. Wright: Well, now, gentlemen, I regret that my time is more than up, and I suppose you will excuse me if I call upon the First Vice-President to take my place.

Mr. Black thereupon took the chair and said: You have all heard me speak a good deal, and I do not propose to make a speech. I thank you all for the honor you have conferred on me in electing me your First Vice-President. I have always had the interests of the Association at heart, and will do my utmost to further its interests in the future.

Mr. Thornton: I would like to move the usual grant to the Secretary of the Association. I think it is usual to do so, and it is a matter which should not be forgotten. I think it is $150.

Mr. Higman: I am very glad to second that motion.

Mr. Black: As the Secretary still has a little work to do, I will read the report of the committee appointed to draft the standing committees. If you wish to make additions or alterations, you are quite at liberty to do so.

Committee on Statistics—A. A. Dion, R. T. MacKeen, R. G. Black, Jas. Robertson.

Committee to Confer with Underwriters—K. B. Thornton, C. B. Hunt, J. J. Wright, W. C. Hawkins, Ed. A. Evans, A. A. Dion.

Committee on Legislation for Ontario—C. B. Hunt, A. A. Wright, B. F. Reesor, J. J. Wright, R. O. McCulloch, Gordon Henderson. For Quebec — A. Sangster, E. A. Evans, L. A. Denis, K. B. Thornton.

Special Committee for Advancement of Interests of Association—K. B. Thornton, R. T. Mackeen, R. G. Black, John Murphy, Louis W. Pratt, J. W. Purcell.

It was moved by Mr. Reesor, and seconded by Mr. Purcell, that the report of the committee be adopted. Carried.

Mr. Black: When the Legislative Committee brought in their report for the present year, they recommended that funds be placed at their disposal to defray the expenses for the coming year. It will be quite in order, therefore, for some one to move that the Executive have power to place at the disposal of the Legislative Committee such funds as they deem advisable to carry on the work.

Mr. J. J. Wright: I move that resolution.

Mr. Higman: I will second that. (Carried.)

Mr. Black: There is nothing definitely arranged about the Shawinigan trip, but it is well worth any one's time to go down.

Mr. J. J. Wright moved that the convention adjourn to meet in Niagara Falls in June, 1906.

OPERATION OF TRANSFORMERS AT VARYING FREQUENCIES AND VOLTAGES.

By M. A. Sammett.

The alternating current transformer holds a prominent place in modern Central Stations. In the investment of the plant it constitutes a considerable portion of the Companies outlay and where the supply of individual customers is done by the aid of step down transformers, the total kilowatt capacity in transformers is equal to three and even four times that of the capacity of the generating plant.

This wide applicátion of transformers commands a thorough understanding of transformer characteristics and it is gratifying to note that of late manufacturing concerns are making an effort to disceminate useful information and thus place in the hands of the operating Engineer data which will enable him to have a more complete understanding of the various types of transformers, methods of testing same for losses, regulation, proper rating, etc., etc.

In view of the fact that the subject of testing has been dealt with in convention papers on previous occasions, I have in this instance selected a subject which will confine itself to characteristics expressing the effect of variable frequency and voltage on transformer operation. The choice of such characteristics suggested itself on the one hand by conditions peculiar to Hydroelectric power development so very extensive in Canada and on the other by the tendency of consolidation, a tendency of International character, aiming at the centralization of the same industries under one management.

Let us take up first the question of influence of variable frequency on the operation of transformers. In various Hydroelectric plants throughout the Dominion, wherever the severe winter generally causes a considerable diminution of the effective head on account of the ice formation in the tail race and forebay, the operating Engineer is sometimes called upon to resort to extreme means in order to carry the Station load at a lower frequency. Often Engineers laying out a plant for low water heads would, providing for such an exigency, specify the generators to be designed with a weak field and low magnetic density in the armature laminations. Then, when the emergency does come and there is no steam plant to fall back on for running the two plants in multiple and thus hold the entire system at the proper frequency the lower voltage, resulting from low speed will be raised by increasing the field excitation. Full normal voltage will be secured and as far as the generator potential is concerned normal conditions will be restored. Let us suppose there is a quantity of water sufficient to carry the load at a lower speed and investigate the effect of lower frequency on transformers intended to operate at a given higher frequency.

It would be impossible to give exact data as to how far it would be permissable to go in lowering the frequency of a given plant without endangering the very life of the apparatus of the system.

This would depend on the characteristics of the generators as well as the various transformers of the system. Granted that the generating machinery was designed to meet such conditions, would the same apply to standard apparatus such as step down transformers for lighting or motor service? What criterion can we use in order not to overstep the safety limit? As stated before, the individual characteristics of the apparatus must be known in every case in order to give a definite answer to this question and a treatment of general principles involved will serve to illustrate the relation between the frequency and transformer performance and to demonstrate their interdependence.

We shall not go into the minute analysis, but concern ourselves only with such points as are of interest to us as Central Station men, leaving the finer details to the designing Engineer.

The points in which we are chiefly interested are those of the affect on the iron losses, (the copper loss remaining practically constant at any frequency,) the exciting current and regulation, points that directly affect the efficiency of the apparatus and consequently the efficiency of the entire system. The difference of iron losses at different periodicities will affect the full load as well as the all day efficiency of the plant. The difference in the exciting current will be responsible for a considerably increased no load current.

We shall also determine the affect of lowering of the frequency on the regulation in order to find their relation. The question of regulation is an important one to Central Stations as the useful life of incandescent lamps depends altogether on the voltage of the circuit to which the lamps are connected and this voltage must be maintained constant requiring close regulation.

To begin with, the first mentioned variable that of the iron loss is, as you all know, composed of the so-called Hysteresis or lag loss due to molecular friction caused by the lagging current of magnetic induction with relation to the magnetizing force as the iron goes through a cycle of magnetization, and the Eddy current loss, which is a loss of energy consumed in setting up induced currents in the iron.

Mr. C. P. Steinmetz, who carried on extensive investigations in connection with Hystersis and Eddy current losses, arrived at certain empirical formula which check very close with actual results and we shall make use of these formulae to get a clearer understanding of the relation between the various quantities which determine the iron loss.

HYSTERESIS LOSS.

In its simplest form the formula reads as follows:—

$$\text{Hysteresis } P_H = xB^{1.6}$$

which is the loss in ergs per cycle for each cubic centimeter of iron. In this expression x is a constant indicáting the quality of iron, depending on the chemical constituents entering it and also on the physical treatment in the manufacture of same. Applying the above expression to any transformer, in order to determine the Hysteresis Loss the formula will be modified by adding two more factors, namely, the volume of iron in cu. cms. and the factor representing frequency.

Hence

$$P_H = xVNB^{1.6} \text{ in ergs}$$

or if expressed in practical units

$$P_H = xVNB^{1.6} \times 10^{-7} \text{ watts.}$$

where x = Constant for given quality of iron.
V = Volume in cu. cms.
N = Frequency in cycles per second.
B = Induction per sq. cm. of iron.

EDDY CURRENT LOSS.

The energy lost in Eddy current reads as follows when expressed in practical units:—

$$P_E = EVN^2B^2 10^{-7}$$

where E = Eddy current constant.

V, N and B = volume, frequency and density expressed in the same units as those in the Hysteresis formula. The Eddy current constant "E" depends on the thickness of the laminations of iron and frequency, varying directly as the square of the thickness, the square of the frequency and directly as the first power of the specific Electric conductivity of the iron. Expressed numerically it reads:

$$E = \frac{(3.14)^2}{6} Z^2 y 10^{-9} = 1.645 Z^2 y 10^{-9}$$

where Z = Thickness in cms. of laminations.
y = Specific Electric Conductivity of iron in megohms

Hence

$$P_H = 1.645 Z^2 y V N^2 B^2 10^{-16} \text{ watts.}$$

The combined loss of Hysteresis and Eddy current generally called Core Loss will be expressed as follows:—

$$\text{Core Loss} = x\frac{VNB^{1.6}}{10^7} + \frac{1.645Z^2yVN^2B^2}{10^{16}} \text{ watts.}$$

Of these the Eddy current loss at commercial frequencies is the smaller one of the two and as it varies directly with the square of the frequency and induction, the higher the frequency and induction the higher the loss due to Eddy current. In standard transformers of good make the Eddy loss vaties from 45 p. c. of the combined iron loss at 125 Cycles to that of 15 to 20 p. c. with a frequency of 25 Cycles.

Frequency	Hysteresis Loss	Eddy Current Loss.
125	55 p. c.	45 p. c.
60	70 p. c.	30 p. c.
25	80-85 p. c.	15-20 p. c.

In order to be able to calculate the change in the iron losses by the aid of the emperical formula given above we shall have to make use of the fundamental formula in alternating current work, the basic formula which expresses the relation between different quantities as they enter into the making of the transformer.

$$E = \sqrt{2} \times 3.14 \times TNAB\, 10^{-8} \text{ or } B = \frac{E10^8}{\sqrt{2} \cdot 3.14 \cdot TNA}$$

where T = Turns of primary or secondary winding.
E = Voltage corresponding to turns of winding given above.
A = Cross section of iron in sq. cms.
B = Induction sq. cm.

Having to deal with transformers in operation, all quantities with the exception of frequency and consequently magnetic density are fixed and we may combine them all under one constant

$$\frac{E10^8}{\sqrt{2} \cdot 3.14 \cdot TA} = k.$$

This will reduce the formula to $B = k\frac{1}{N}$

Thus we see that magnetic density is inversely proportional to the frequency, that is to say, with a frequency half that of the original or normal frequency the density will be double normal density and with frequency twice as high as normal frequency we will have half normal induction, or with a change from 60 to 30 Cycles the induction will be double that it was at 60 Cycles.

Referring to formula of Hysteresis $P_{H60} = c \cdot V \cdot N \cdot B^{1.6} \cdot 10^{-7} = c \cdot V \cdot 60 \cdot B^{1.6} \cdot 10^{-7}$; when frequency is changed to 30 Cycles $P_{H30} = c \cdot V \cdot 30 \cdot (2B)^{1.6} \cdot 10^{-7} = c \cdot V \cdot (30 \times 2) \cdot 2^{0.6} \cdot B^{1.6} \cdot 10^{-7} = c \cdot V \cdot 60 \cdot B^{1.6} \cdot 10^{-7} \cdot 1.516$.

which means that a reduction in frequency from 60 to 30 will increase the Hysteresis loss 51.6 p. c.

The Eddy current loss in a given transformer, as will be shown by the equations below, is a constant loss, depending on the voltage alone. The two variables, namely frequency and induction, entering the expression as Squares of the inverse quantities, neutralize each other.

$$P_{E60} = \frac{1.645 Z \cdot v B^2 \cdot N^2 \cdot V}{10^{16}}; \quad P_{E30} = \frac{1.645 Z \cdot v (2B)^2 (\frac{1}{2} N)^2 V}{10^{16}};$$

Hysteresis varying in the inverse ratio of frequencies raised to the power 0.6 we have the following relation.

New Hysteresis is equal to normal Hysteresis multiplied by

$$\left(\frac{\text{Normal frequency}}{\text{New frequency}}\right)^{0.6};$$

This expression will be helpful in enabling us to find the constants of conversion from existing frequencies to any new frequency.

Taking the Hysteresis at 133 Cycles as unity, we get the following constants of conversion:

FREQUENCY	HYSTERESIS	EDDY CURRENT
133	1.00	0.82
125	1.038	"
100	1.187	"
66	1.522	"
63	1.566	"
60	1.612	"
50	1.799	"
40	2.056	"
33	2.308	"
30	2.443	"
25	2.726	"

In this table the Eddy current loss is given as 82 p. c. of the Hysteresis loss at 133 Cycles and will remain a constant for all frequencies.

This table shows that a decrease in frequency will result in an increase in Hysteresis and consequently in a higher temperature of the transformer iron. In oil immersed as well as dry self cooling transformers this increased temperature rise of the iron will cut down the current carrying capacity of the transformers and what would under normal conditions be called normal load would with a lower frequency be an overload and may cause the burn out of the transformer.

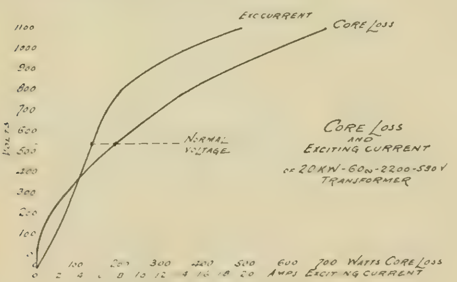


Fig. 1.

All standard transformers for lighting and motor service are manufactured so as to operate at a considerable range of frequencies and they are generally subdivided into two classes, "The High Frequency" and "Low Frequency Transformers." The former adopted for use on circuits from 60 to 140 and the latter from 40 to 140 Cycles. While they will be guaranteed to operate satisfactorily within the ranges given above they will have to be rerated as the various iron losses at different frequencies will increase the temperature at which the transformers operate, hence diminish their capacity. This consideration will add more weight to the importance of selecting transformers with a low core loss, a consideration so very vital for the all day efficiency of a plant with a heavy lighting load.

Taking up now the question of unification of two existing systems operating at different periodicities the conclusions arrived at in this paper would at once suggest that the lower frequency should be raised whenever possible and the higher frequency should be made standard. Such a change would decrease the energy dissipated in the iron of transformers of lower periodicity and they would operate at a temperature below that of previous normal conditions. While this policy should always be followed by Hydroelectric plants wherever conditions permit of such a change, it is of still greater importance to steam generating plants where high core loss resulting from lowering of the frequency, besides the fact of decreased transformer load carrying capacity, means also an increased coal consumption, two factors detrimental to the economy of the plant.

Often, however, local conditions make it impossible to raise the frequency above a given point and then a compromise frequency would be the best way out of the difficulty.

We will now take the figures, given by one of the largest manufacturing concerns as guarantees of iron and

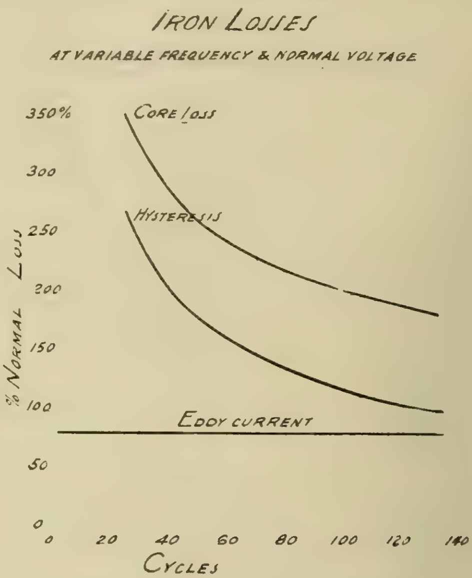


Fig. 2.

copper losses of their standard transformers and applying the constants of conversion given in the table, determine the effect of a change from 60 Cycles to that of 40 Cycles.

High frequency transformers 60 Cycles-2080-104-208 volts.

K. W.	Core Loss in Watts.	Copper Loss in Watts.	Total Loss in Watts.
1	39	27	66
3	62	65	127
5	95	94	189
7.05	117	125	242
10	156	147	303
15	202	215	417
20	232	290	522
25	258	327	585
30	302	394	696
	40 Cycles = 2 080-104-208 volts. K = 1.186		
1	46.5	27	73.5
3	74.0	65	139.0
5	113.0	94	207.0
7.5	139.0	125	264.0
10	185.0	147	332.0
15	240.0	215	455.0
20	276.0	290	566.0
25	307.0	327	634.0
30	359.0	394	753.0

Thus we see that the lowering of the frequency from 60 to 40 will result in an iron loss of a 30 K. W. transformer of 57 watts higher than prior to the change and in order to keep the temperature within the same limits it would be necessary to decrease the current carrying capacity by the same number of watts. A reduction of 57 watts will bring the copper loss to 337 watts or to 85.5 p.c. originally normal copper loss and consequently to 92.5 p. c. of transformer capacity.

A change to a system of 30 Cycles will give the following losses:

K. W.	Core Loss in Watts	Copper Loss in Watts.	Total Loss
	K. = 1.34		
1	52.5	27	79.5
3	83.0	65	148.0
5	127.0	94	221.0
7.5	157.0	125	282.0
10	209.0	147	356.0
15	271.0	215	486.0
20	311.0	290	601.0
25	346.0	327	673.0
30	405.0	394	799.0

Taking the same 30 K. W. transformer we find the Core Loss increased by 103 watts. A corresponding decrease in Copper Loss will reduce the latter to 292 watts or 74.1 p.c. normal copper loss, thus making the load carrying capacity of the transformer in K.V.A. only 86 p. c. that of normal.

The above figures giving the per cent. normal load

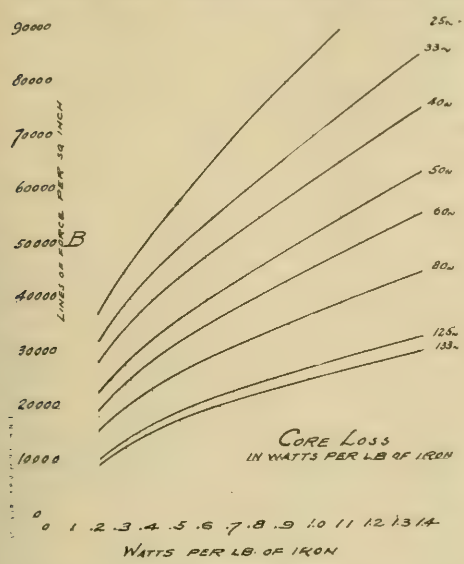


Fig. 3.

capacity are favorable as compared to the large Station transformers which are designed with an iron loss considerably in excess of the copper loss, sometimes differing as much as to be twice the loss in the copper. You will readily see then that the capacity of the apparatus under these conditions would be greatly reduced with the increase in iron loss.

Assuming the Core Loss to be twice as high as the Copper Loss when operating at 60 Cycles what should be the

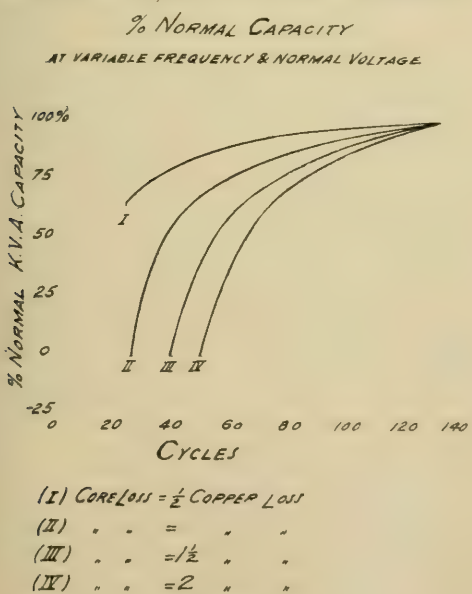


Fig. 4.

transformer rating at 30 Cycles? Core Loss at 30 = Core Loss at 60 x 1.34. (1.34 is constant derived from our table including both the Hysteresis and Eddy current losses.) This increase will make the energy dissipated in the iron 2.68x, where x is watts loss in the copper (instead of 2.00x) and the energy permissable to be dissipated by the coils to make up the same total energy loss of 3.00x for the same operating temperature will be 0.32x. The K. V. A. capacity varies directly as the square root of the energy lost in the winding. Consequently the transformer = capacity $\sqrt{0.32} = 0.565$ or 56.5 p. c. normal capacity.

EXCITING CURRENT.

The exciting current is the vectorial sum of the magnetizing or wattless current and the energy current supplying the Hysteresis loss. The two components are at right angles to each other and the exciting current I_E can be expressed as $I_E = \sqrt{I_M^2 + I_H^2}$

where I_M = Magnetizing current

I_H = Hysteresis current

I_M in well designed transformers is equal to the Hysteresis current and this can be found by diving the Hysteresis watts into the impressed voltage.

Hysteresis watts as we have found before are equal to $P_H = xVNB^{1.6}\,10^{-7}$;

giving for the Hysteresis current $I_H = \dfrac{xVNB^{1.6}\,10^{-7}}{E}$

The magnetizing current being equal in magnitude to the Hysteresis current, the exciting current will be equal to

$$1.41\,\frac{xVNB^{1.6}}{E10^{7}}.$$

Thus we find the exciting current varies as the 1.6 power of magnetic induction, which in its turn varies inversly as the frequency. So that a lowering in frequency will increase the exciting current and naturally decrease the no load efficiency of the transformer as well as the entire plant.

REGULATION.

By regulation is meant the difference between the secondary voltage under conditions of load and with secondary coils open circuited, when a constant primary voltage is impressed. The regulation of a given transformer with a non-inductive load is so much different than the regulation when the load is inductive that it is essential to specify the nature of the load. It would be well to state here that in a given station operating Synchronons motors the lowering of the frequency would be prohibitive and even in the case of induction motors the change of speed cannot be allowed to fall more than 5 or 10 p.c. below the normal which is from 2 to 5 per cent. lower than the Synchronons speed. The only inductive load possible to be carried at frequencies below normal would be that of series alternating enclosed arc lamps. These operate as a rule at 60 Cycles, but will operate satisfactorily at 50 Cycles as is the case in many plants in Europe. 50 Cycles will serve as a limiting line, since at lower periodicities the arc becomes unstable. In incandescent lighting the critical point is reached at about 25 Cycles and therefore, plants operating at 40 Cycles may, other conditions permitting, drop in frequency to that point and yet give satisfactory service.

Confining ourselves to non-induction load only how would the regulation be affected with a frequency below normal?

$$\text{Regulation in } \% = 100 - \left[100 \times \frac{\text{Secondary volts full load}}{\text{Secondary volts no load}}\right]$$

Regulation when expressed in terms determining the various values in the transformer, can be expressed as follows:

$$\text{Regulation} = \frac{\sqrt{(100 - PIR + WIX)^2 + (IX)^2} - 100}{E}$$

where $(100 - PIR + IX)$ is the voltage in phase and IX is quadrature voltage.

P = Power factor = 100 with non-inductive load.

IR = Pr. + Sec. drop in %.

W = Magnetizing current in % of full load current.

IX = Reactive drop in %.

The values affected in this formula are those of magnetizing current, and reactive drop, resistance remaining constant at all frequencies, and since WIX is only a small fraction of one per cent., we are safe in saying that the change in regulation of a transformer operating at 60 to 30 Cycles will hardly exceed in well designed transformers more than 0.1 p. c.

The above discussion leads us then to the following conclusions:

A lowering of frequencies from 60 to 40 Cycles will increase our Core Loss 18.6 p. c. A lowering from 60 to 30 Cycles will increase it 34 p. c.

Transformer capacity will decrease in the first instance to 92.5 p. c. normal capacity; in the second to 86.0 p. c. In the case of large station transformers (oil immersed) where the iron loss is about twice that of copper loss, the capacity with a change from 60 to 30 Cycles would be cut in half. With Air Blast transformers the capacity may be left unchanged when operated on a lower frequency, provided the irons can be cooled effectively to keep them at normal temperatures.

The exciting current will rise with the falling off of frequency at about the same rate as the Hysteresis Loss. Regulation is affected but slightly, the lowering of the fre-

quency causing better regulation, but within 50 p. c. variation of frequency the difference will not exceed 0.1 p. c.

CHARACTERISTICS AT VARIABLE VOLTAGE.

We have seen low transformers would operate at a frequency different from the one they are intended for, and we shall now investigate as to the affect of variable voltage on the same apparatus.

Transformers when used at voltages lower than normal will have the benefit of a lower iron loss. It will be unsafe, however, to increase beyond a certain limit the ampere capacity of the transformer to compensate for the gain in Core Loss as the excessive current density in the copper may result in an abnormal rise of temperature in the winding, though the combined iron and copper loss are kept constant. The table given below is compiled on the assumption of a constant total loss and whatever gain was derived from a lower operating voltage was taken advantage of by allowing a larger load current. The capacity of the transformer was also calculated, but on purely K. V. A. basis without any allowance made for proper correction as to temperatures. It was assumed in this computation that the iron and copper losses are equal at normal voltage.

p.c. Normal Voltage	p.c. Normal Core Loss	p.c. Gain Core Loss	p.c. Normal Current	p.c. Capacity K.V.A.
10	2.5	97.5	140.5	14.05
25	10.9	89.1	137.5	34.4
50	33.0	67.0	129.2	64.6
75	63.0	37.0	117 0	87.75
100	100.0	0	100	100
125	149.0	49.0	71.4	89.5
150	191.0	91.0	3.0	4.5

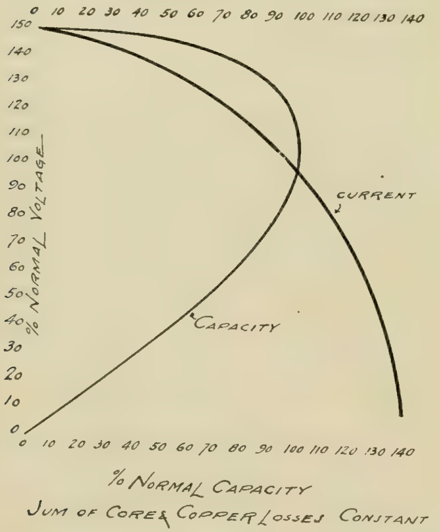


Fig. 5.

The figures and the accompanying curves show the capacity greatly decreased when the voltage differs from normal. With an increase of voltage 50 p.c. the Core Loss amounts to 95.5 p.c. of the combined copper and iron losses and when the transformer operates at 10 p.c. Normal voltage the copper loss is equal to 70.25 p. c. of the combined losses. In both instances the capacity in K. V. A. is greatly reduced.

CORE LOSS.

We shall refer once more to our fundamental formula

$E = \frac{\sqrt{2} \cdot 3.14 \cdot TNAB}{10^8}$ where T, N and A are constant values,

Hence calling $\frac{\sqrt{2} \cdot 3.14 \cdot TNA}{10^8} = k$ we get $E = k B$.

or at constant frequency, the magnetic induction varies directly as the voltage and since the Hysteresis varies directly with 1.6 the power of induction while the Eddy current varies directly as the square of induction, the Core loss will vary as some value between 1.6 and 2.0 of the induction depending on the frequency at which these transformers are operating.

Let us consider the frequency of 60 Cycles and find the multiplier expressing the relation between volts and induction.

From the table of constants of conversion of Hysteresis and Eddy currents, we find that the Eddy current loss constitutes 38 p. c. of normal Core loss. Hysteresis 62 p. c. of iron loss, varying as 1.6 power of induction and Eddy current 38 p.c.ofiron loss varying as the square of induction.

An increase in say, 10 p. c. above normal voltage will cause a corresponding increase in induction. The hysteresis loss will rise by $(1.1)^{1.6}$; while Eddy current loss will rise by $(1.1)^2$.

Reducing the expression to a simpler form, we find the Hysteresis equal to 1.165 of the normal loss of 62 p. c. and the Eddy current equal to 1.21 of the normal loss of 38 p. c. or expressing it in times of core loss it will be 1.182 times the normal Core Loss.

The higher iron loss will reduce the current of the trans-

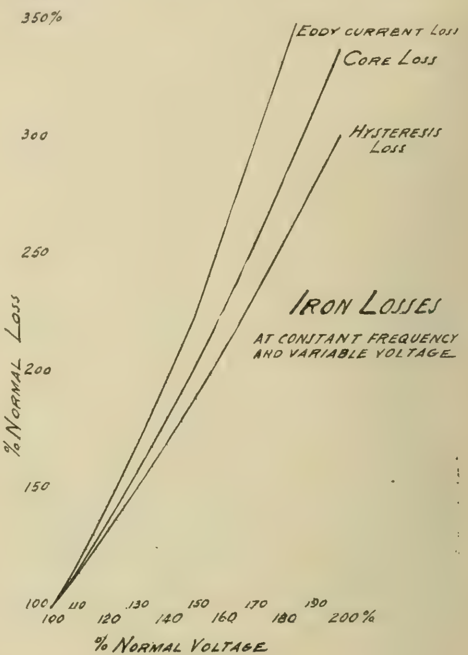


Fig. 6.

former for the same K.V.A. capacity, making the current 90.9 p. c. of the normal current and reducing the copper loss to 82.6 p. c. of normal loss.

So we find an increased iron loss of 18.2 p. c. to be accompanied by a decrease in copper loss equivalent to 17.4 p. c. The iron loss being larger than the gain in copper loss by 0.8 p. c. the all day as well as full load efficiency will be somewhat less.

An increase in 20 p. c. above normal voltage will affect the transformer as follows:—

Hysteresis will increase 34.0 p. c.

Eddy current will increase 44.0 p. c.,

and the combined loss will increase 37.8 p. c. For the same K.V.A. the current in the coils will be only 83.3 p. c. of normal and the gain in copper loss resulting from same will be 30.6 p. c. The excess of the increased iron loss over the gain in copper loss amountsto 7.2 p. c. which makes the increase in voltage of 20 p. c. prohibitive. Besides the question of excessive Core Loss, the excessive exciting current will enter in consideration as well as the diminished factor of safety in the insulating material will have to be contended with.

A decrease in 10 p. c. of normal frequency will give us the following per cent. of gain and loss.

Core loss will be decreased to $0.90^{1.6} = 84.5\%$ Normal Hysteresis, $0.90^2 = 81.0\%$ Normal Eddy Loss.

The combined iron loss amounting to 83.1 p. c. Normal Core Loss, or a gain of 16.9 p. c. and the copper loss increasing 21.0 p. c. This condition is not as favorable as an increase in voltage by the same amount. Thus we see that a change of 10 p. c. above the voltage the transformers are designed for will allow satisfactory operation and increase the total loss by 0.8 p. c. affecting the result as to the efficiency of either the transformers or the plant but very slightly, while a higher change in voltage will affect the efficiency of the apparatus as well as its rating to a considerable degree. Taking the same guarantee losses as those discussed under the heading of the affect of variable frequency and correcting same by the factors given above we get the following losses:

CORE LOSS.

Normal conditions, Losses as guaranteed.
60 Cycles — 2080 — 104-208 Volts.

K. W.	Core Loss in Watts in Watts	Copper Loss in Watts. in Watts.	Total Loss
1	39	27	66
3	62	65	127
5	95	94	189
7.5	117	125	242
10.0	156	147	303
15	202	215	417
20	232	290	522
25	258	327	585
30	302	394	696

Computed losses. Voltage 10 p. c. above normal

1	46	22.5	68.5
3	73	54	127.0
5	112	78.0	190.0
7.5	138	103.0	241.0
10	184	121.5	305.5
15	238	177.5	415.5
20	274	239.0	513.0
25	305	270.0	575.0
30	355	325.0	680.0

Voltage 10 p. c. below normal

1	32.5	33.0	65.5
3	51.5	79.0	130.5
5	79.0	114.0	193.0
7.5	97.0	153	250.0
10	130.0	178	308.0
15	168.0	260	428.0
20	193.0	351	544.0
25	214.0	396	610.0
30	251.0	477	728.0

Voltage 20 p. c. above normal

1	4	19.0	73.0
3	85.5	45.0	130.5
5	131.0	65.0	196.5
7.5	161.0	87.0	248.0
10	215.0	102.0	317.0
15	278.0	149.0	427.0
20	320.0	201.0	521.0
25	356.0	227.0	583.0
30	417.0	274.0	691.0

Voltage 30 p. c. above normal.

1	62.0	16.0	78.0
3	98.0	35.5	133.5
5	150.0	55.5	205.5
7.5	185.5	74.0	259.5
10	247.0	87.0	334.0
15	320.0	127.0	447.0
20	368.0	171.0	519.0
25	409.0	193.0	602.0
30	479.0	232.0	711.0

Voltage 50 p. c. above normal

1	79.5	12.0	91.5
3	127.0	29.0	156.0
5	194.0	42.0	236.0
7.5	239.0	55.5	294.5
10	318.0	65.0	383.0
15	412.0	95.0	507.0
20	473.0	129.0	602.0
25	526.0	145.0	771.0
30	616.0	175.0	

Voltage 100 p. c above normal.

1	133.0	7.0	140.0
3	210.0	16.0	226.0
5	325.0	23.5	348.5
7.5	400.0	31.0	431.0
10	530.0	37.0	567.0
15	686.0	54.0	740.0
20	790.0	72.5	862.0
25	877.0	81.5	958.5
30	1030.0	98.5	1128.5

While small standard transformers may be easily put on a circuit of double voltage, the apparatus in larger sizes is often designed at considerably higher induction and double voltage impressed on the transformer will even with the transformer secondary open circuited take a considerable load, the iron being pretty well magnetically saturated.

The difficulty of dealing with saturated iron on over-potential test becomes very pronounced when manufacturers undertake to build apparatus which they guarantee to withstand a triple potential across the transformer coils.

At an acceptance test witnessed by the speaker, the manufacturer, endeavoring to demonstrate the safety of the apparatus at triple normal voltage, resorted to a high frequency machine, which was a 133 Cycle machine speeded up to 165 Cycles, and then succeeded in impressing only double voltage. The high speed of the alternator caused an excessive armature reaction and the demagnetized alternator field would not generate a voltage high enough for the test.

The transformers were of the Air Blast type, 100 K.W., the high frequency alternator running at 165 Cycles and while reducing greatly the Hysteresis loss increased the Eddy current loss on account of the increased frequency.

Let us get at the actual figures in this particular instance. The transformer as stated was to operate at 60 Cycles. Core Loss at normal voltage was equal to 11,000 watts. If 62 per cent. of this loss is Hysteresis and 38 per cent. Eddy current, the iron losses will be 6,820 and 4,180 watts respectively. With an increase of frequency to 180 and a rise in voltage to three times normal, the Hysteresis loss will come to 22,700 watts, as against the original Hysteresis loss of 6,820 watts. And the Eddy

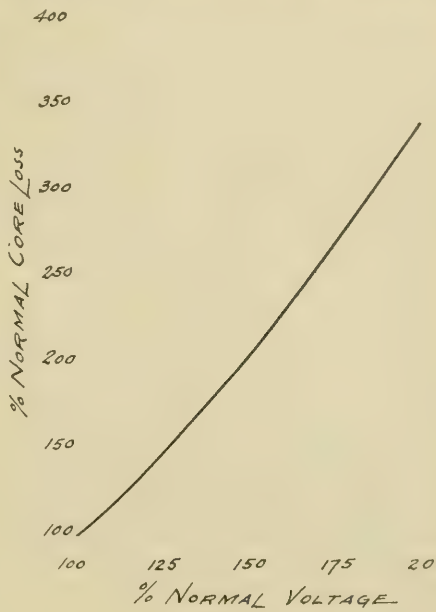


Fig. 7.

current loss at same potential will be 37,200 watts, as against 4,180 watts. Total loss in the iron amounting to 59,900 watts.

This example is made mention of as an extreme case to illustrate more vividly the behavior of transformers at a voltage much in excess of normal voltage.

EXCITING CURRENT.

With increased voltage there will be an increased exciting current in consequence of a proportionally larger induction.

$$\text{Exciting Current} = 1.41\, K \frac{B^{1.6}}{E}$$

Since B varies directly as E any increase in voltage will increase the exciting current. With a constant frequency this increased current will be smaller for the same change as expressed in per cent.., when compared with the increase at variable frequency and constant voltage.

For instance a change in voltage of 20 per cent. above normal will increase the exciting current, making it

$$K \frac{(1.2\,B)^{1.6}}{1.2\,E} = K \frac{B^{1.6}}{E} \times \frac{1.2^{1.6}}{1.2} = 1.11 \times K \frac{B^{1.6}}{E};$$

or an increase of 11 per cent. While a change in frequency amounting to 20 per cent. will affect the exciting current by as follows:

$$K \times 80\% N \times (1.25 B)^{1.6} = 1.14 K N B^{1.6};$$

an increase of 14 per cent.

REGULATION.

A voltage different from that of normal not to be detrimental to the operation of synchronons and induction motors must not exceed much that of normal voltage. We shall therefore confine ourselves to a change of 10 and 20 per cent. and see how this would affect regulation for both non-inductive and inductive load. Wherever there is

a motor load a reduction in voltage would not be advisable.

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + IX)^2 + (IX)^2} - 100}{E}$$

Non-inductive load. Voltage 10 per cent. above normal.

An increase in voltage 10 per cent. will decrease the current to 90. 9 per cent. normal, IX will decrease to 90.9% and WIX = 100.8%.

Hence

Regulation will be improved.

INDUCTIVE LOAD.

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + WIX)^2 + (PIX - WIR)^2} - 100}{E}$$

An examination of this formula will show at a glance, applying the correcting factors to the various quantities, that the regulation will be improved by raising the voltage 10 or 20 p. c.

TO RECAPITULATE

A higher voltage amounting to 10 or 20 p. c. will not affect the losses materially except that the increased Core loss will reduce the all day efficiency of the transformers. This difference in the instance of 10 p. c. rise will amount to 0.8 p. c. and at 20 p. c. rise higher losses will result in higher heating on account of increased Core Loss and danger of break down, due to higher voltage.

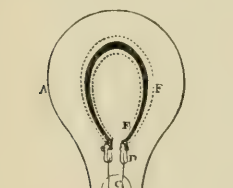
A lowering of 10 p. c. will result in an increased all day efficiency but will reduce the full loss efficiency as well as cause the transformer to run hotter.

The exciting current will increase with increased voltage, thus making the no load current feeding the transformers larger. The Regulation at either non-inductive or inductive load will be improved.

SOME NOTES ON THE INCANDESCENT LAMP.

By A. B. Lambe.

Contrary to what would seem to be the understanding of many electric lighting Companies, the subject for our consideration this evening, the Incandescent Lamp, is one of the most important pieces of apparatus which they are called upon to use and consider, because after all is said and done it is the end and object of the most costly and well planned systems of engines, lines and transformers, more than this it is that part, and practically the only part, of the system in view of both present and prospective customers, and therefore the one by which both the Company and the service it offers are judged. It is remarkable in many ways, not the least of which is that it was practically a perfect piece of mechanism when first designed, containing in Edison's original form, shown in Fig. 1, reproduced from an issue of the *Graphic* dated about



A. The Vacuum Globe. B. Interior Glass Crest, through which wires pass to light. C. Platinum Wires. D. Platinum Clamp. E. Carbonized Cardboard. F. Dotted Line, showing size of Incandescence equal to Sixteen Candles. G. Copper Wire to Meter and Generator. H. Wooden Stand. X X. Binding Posts.

Fig. 1.—Edison's First Commercial Lamp.

1880, all the essential parts found in the latest product of the present day. It has survived many changes in methods of generation and distribution, has given equal satisfaction on both alternating and direct current, has adapted itself to potentials of 200 volts and higher, has kept pace with all reductions in frequency, and forms to-day the mainstay of central station revenue. It consists essentially of a conducting medium, the filament, which gives out the light, a glass bulb to keep air away from the filament so that this latter will not burn away so quickly as it otherwise would, and the base, the function of this being both to form the electrical connection between the filament and the supply circuit and to hold the lamp in position. Before however discussing these different parts it is perhaps desirable to first consider the question of light and its measurement, the production of light being the main field of the incandescent lamp.

Light being a saleable article there immediately arises, as with all other commercial commodities, the necessity for a set of units as a common basis for comparison and measurement. These are three in number, viz.: The Unit of Light, which is known as the Candle Power; the Unit of Illumination, the Candle Foot; and the Unit of Intrinsic Brightness, which is generally accepted as one Candle Power per Square Inch. The first refers to the source of light and the amount which it can emit, the second to the illumination of any specified surface, and the third to the relative brightness of the source of light, that is, assuming a given candle power, as to whether the luminous surface is relatively large, in which event the intrinsic brightness is low, or whether it is comparatively small, which means high intrinsic brightness. A detail consideration of this factor, besides requiring too much time, is somewhat outside the limits of our subject, but the following table from Dr. Louis Bell's "Art of Illumination" will be interesting:

Intrinsic Brilliancies in Candle Power Per Square Inch.

Source.	Brilliancy.	Notes.
Sun in Zenith	600,000	Rough equivalent values taking account of absorption.
Sun at 30° Elev	500,000	
Sun on Horizon	2,000	
Arc Light	10,000 to 100,000	Maximum about 200,000 in crater
Calcium Light	5,000	
Nernst "Glower"	1,000	Unshaded.
Carbon Incandescent Lamp	200-300	Depending on Efficiency.
Melting Platinum	130	1 square cm = 18.5 c.p.
Enclosed Arc	75-100	Opalescent inner globe.
Acetylene Flame	75-100	
Welsbach Light	20 to 25	
Kerosene Light	4 to 8	Very variable.
Candle	3 to 4	
Gas Flame	3 to 8	Very variable.
Carbon Incan. Lamp (Frosted)	2 to 5	
Opal Shaded Lamps, etc.	0.5 to 2	
Tantalum Lamp	500	

In England and on this Continent the Candle Power is the light emitted by a candle which weighs one-sixth of a pound and consumes 120 grains of spermaceti per hour, being known as the English Parliamentary standard. On the Continent and

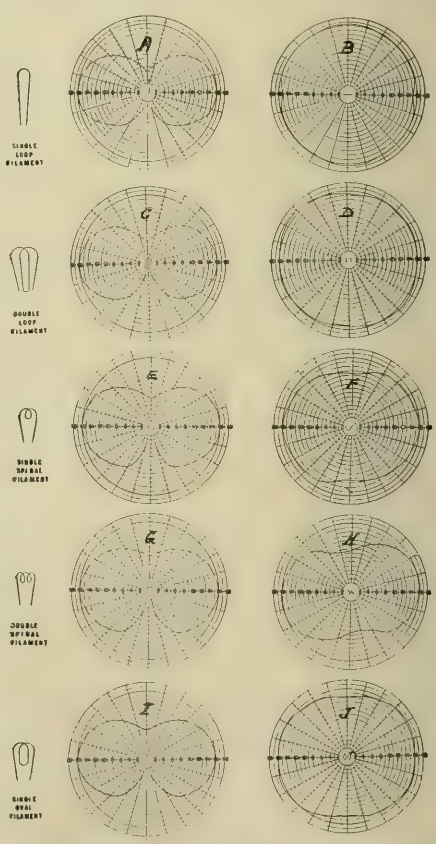


Fig. 2.—Distribution of Light From Different Types of Filaments. The Left Hand Curves Show the Distribution in a Vertical Plane, Those at the Right the Corresponding Horizontal Distribution.

in some other parts of the globe they consider as standard the Hefner amyl-acetate lamp, which gives a light 88 per cent. that of the other.

The Candle Foot is defined as the direct illumination given by a standard candle placed one foot away from the object illuminated. At other distances the illumination is determined by what is known as "The Law of Inverse Squares," which states that the intensity of any light varies inversely as the square of the distance from the source. Thus if we have an object lighted by a 16 c.p. lamp placed a foot away, the illumination is 16 candle feet, if two feet away it is reduced to four candle feet, and so on. For ordinary reading and writing an illumination of one to two candle feet is usually satisfactory. It should be noted that this law of inverse squares holds only in cases free from refraction or reflection, which as a rule are very rare.

The unit in incandescent lighting is the 16 c.p. lamp, this being the size which is most carefully proportioned and highly developed, and which forms by far the largest percentage of present-day consumption. The derivation of what would seem to be the rather peculiar figure of 16 is interesting, it is that as the incandescent lamp when it first came on the market had to compete with the illuminants already in use, gas and oil, it was naturally advisable to make it equivalent to them; tests showing that they gave about 16 c.p., the newcomer was also made of this value. Having a standard we must have means of perpetuating it, and this is accomplished by the use of standard incandescent lamps, made of low efficiency so that they will change but little with use, and which, after seasoning, are very carefully calibrated, that is, the voltage at which they will give their rated candle power determined down to a very fine point. Standards are made on this continent, in addition to the various lamp manufacturers, by the Lamp Testing Bureau of New York City, now an independent company, though at first an organization controlled by the users of Edison lamps. Besides the Lamp Testing Bureau there is the German Richenstahlt, a Governmental institution in Berlin, Germany, which is probably the highest light authority in the world.

Light is measured by an instrument called a Photometer, the principle of which is—without having space for any detailed description—that the light from the source under measurement is balanced against that from a standard by shifting backwards and forwards a traveller containing the necessary arrangement of a shadow producing object—usually a grease spot—and mirrors to transmit the two shadows to the operator's eye. The position required of the traveller to make the shadows equal determines the relative candle power of the two lamps.

Seeing that the major part of the light is given out at right angles to the filament surface it is evident that different types of filaments will give different distributions of their light, that is, though the total from two lamps may be the same, their respective illuminations of a given point may be very different. In order to determine the distribution from the different types of filaments many readings have been made on the various forms and the results plotted on curves as the most satisfactory method of displaying and using the results. Such a series is shown in Fig. 2, which covers both the horizontal and vertical distribution of the filaments in more general use, I, the single oval form, being that found in the great majority of lamps, hence its name of regular type. From

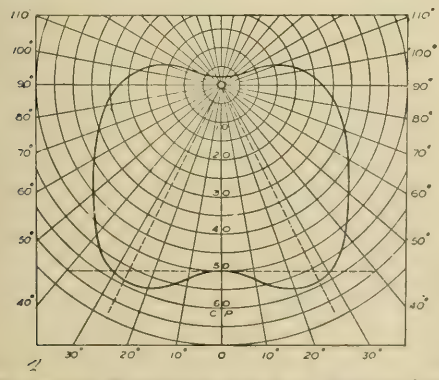


Fig. 3.—Light Distribution from 50 C. P. Meridian Lamp.

this curve you will notice that the 16 c.p. lamp of this form gives a tip or end light of about 7 c.p., while up above there is practically none. In diagram G are found the vertical plane results from the double spiral type of filament, and while this gives what it is designed for, a larger tip or end light, you will see from curve H, which shows its horizontal plane distribution, that the candle power from this form varies considerably as you walk round the lamp. As compared with this, curve J, which is the horizontal result from the single oval, shows the latter's distribution in this plane to be much more uniform. This is quite an important point and one which should not be overlooked in choosing your type of lamp, another advantage is that the relatively larger side light is an aid towards obtaining more even illumination between lamps. From these curves you see how materially the distribution is changed by varying the shape of the filament; besides this it can be altered by the use of reflectors, which, by shaping them in the proper manner, can be made to concentrate or diffuse as desired. These two factors, the shade and the special type of filament, alone or in combination, form the basis of all such lamps as the Shelby, Sunburst, Zenith, and Meridian, or any other types designed to give a special distribution of their light. Fig. 3 is typical of the vertical plane distribution of this latter class. It is interesting to note that frosting also changes the distribution somewhat, decreasing the horizontal and increasing the tip candle power, though, contrary, to popular impression, it does not cut off much light, only 3 or 4 per cent., or about half a candle on a 16 c.p. lamp.

When comparing lamps of different types it is not satisfactory to measure the candle power in one direction only,

Type of Filament See Fig. 2.	Horizontal W.P.C. at which to test various lamps to bring them to the same basis as the Single Oval filament.
Single Oval	3.5
Single Spiral	3.5
Double Spiral	3.52
Single Loop	3.41
Double Loop	3.415

Fig. 4.—Factors for Use When Making Life Tests on Filaments of Different Types.

because, even with all showing the same light when viewed from some given point, the light in other directions, and therefore the total light emitted, may vary considerably. This means that the lamps vary in efficiency, so that they cannot be expected to give the same life even if they all consume the same total wattage. Thus when comparing lamps of different types you must get a common basis for comparison, and this is found in what is called "Mean Spherical Candle Power," or the candle power a lamp would give if radiating an equal amount of light in all directions. It is the average of all the measurements forming any one of the left-hand curves shown in Fig. 2, the light measured along the horizontal lines being horizontal candle power. The relation between the two of course varies considerably with the different types of filaments; to obtain it you may either go to the trouble of plotting curves such as these or you can use the correction factors shown in Fig. 4, which have been deduced from many extensive experiments. This point of average spherical candle power is most important and one worthy of repetition, viz: You must when comparing lamps of different types bring your measurements to the common basis of mean spherical and not horizontal candle power, otherwise your results are entirely wrong and most unfair to one lamp or the other.

Another method of tabulating the results from lamp measurements is contained in Fig. 5, which shows a diagram that

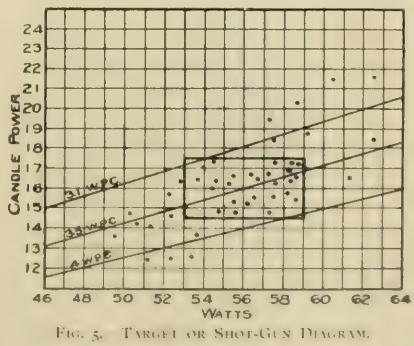


Fig. 5. Target or Shot-Gun Diagram.

takes account of not only the candle power emitted but also of the total watts consumed. It is known as a "shot gun" or target diagram, and being very convenient is used to record nearly all candle power and wattage tests. The reading of each lamp in candle power and volts is shown by a dot, the heavy lines in the centre marking the extreme candle power

and wattage limits permitted by the particular specifications under which you may be working; as such the space enclosed may be called the test or specification area. The inclined lines show the efficiency. The point to be particularly noted is that a lamp low in total watts is not necessarily of high efficiency, because it may not be giving its rated candle power. This should prevent us falling into the frequent error of thinking that, because a lamp is of low total watts and yet gives a longer life than another which consumes more energy, it is the better lamp. You must measure the candle power as well as the wattage; frequently the lamp which is low in the latter is even worse as regards its light giving properties, obviously it is then of low efficiency and incorrectly rated, yet must of necessity give longer life than the more accurately measured product.

Unless otherwise specified an incandescent lamp is always measured horizontally, that is with the lamp vertical, and revolving at 180 R.P.M., horizontally to match gas and oil flames which have to burn vertically and thus give practically all of their light in the other direction, and revolving because, as you have already seen from the right-hand curves in Fig. 2, particularly H, the light varies according to the position from which the filament is viewed; revolving the lamp tends to eliminate this variation. It should be noted that the light from any given lamp is not a fixed quantity unless the voltage also be fixed, because raising or lowering this latter means a corresponding or rather an even greater percentage alteration in the former. For instance one volt change in the potential on a 100-130 volt 16 c.p. lamp will make about one candle power difference in the light, and a corresponding variation in other sizes. This can be put in another approximate rule, viz., that the candle power percentage change is about five to six times that of the voltage, Fig. 9 showing the results in detail.

The foregoing is a brief outline of the method of measuring, tabulating, and comparing the light from incandescent lamps. Next in order come their mechanical features, which can conveniently be discussed under the headings of Filament, Stem, Base, and Bulb.

FILAMENTS: While platinum has been tried for use in filaments it has not proved nearly as satisfactory as carbon, which is the material in general use to-day. On the other hand the work of the last year or two seems to indicate that we are now in a fair way towards getting commercial filaments from some of the more refractory metals, such as osmium and tantalum. Should this turn out to be the case we will then be able to operate at efficiencies of 1½ to 2 w.p.c. as compared with the 3 to 4 w.p.c. limit of to-day, in other words the light capacity of your plant will be doubled. Carbon filaments are obtained from three sources—cellulose, silk, and bamboo—the two latter being used for the large conductors required by high amperage lamps, and cellulose for practically everything else. The process of manufacturing the latter is naturally most intricate and more or less a trade secret. In outline it is first to make a pulp from filter paper or absorbent cotton, the basic materials, after which the mass is dissolved in a solution such as chloride of zinc and then partially evaporated. Next it is squirted through a very fine aperture, which produces the thread-like form, immersion in alcohol serving to harden it. After this it goes through a variety of treatments before assuming its final shape, the principal being that known as flashing or treating. This consists in electrically heating the filament while surrounded by a hydro-carbon gas, the result being the decomposition of the latter, the constituents of which deposit themselves on the filament and unite with it. Previous to this stage these latter occasionally contain high resistance spots, due partly to small

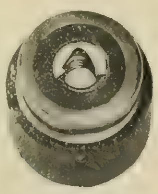


Fig. 6.—Locking Adapter.

diameters and partly to a difference in composition. These naturally get hotter than the rest of the filament, which in turn means a heavier deposit there than elsewhere, and as this depositing or plating has the effect of reducing the resistance it will thus be seen that any high resistance spots are automatically brought to the same conductivity as the rest of the filament, in other words the process makes these latter as far as possible of the same characteristics throughout their whole length. Another electrical effect besides evening the resistance is to reduce it throughout to quite a marked degree, so much so that in some high volt and some low candle power lamps, where a high resistance filament is a natural necessity, treating would bring it below the permissible point, which means that in these cases an untreated filament has to be used. Another effect of this process is to turn the filament from a dull dead black to a smooth steely gray, this forming a comparatively easy means of distinguishing between the treated and untreated types. At this point it is valuable to note that, efficiency candle power and type of filament remaining constant, the higher the voltage the smaller the filament, because the higher the voltage with a given total watts the smaller must be the amperage, if you reduce the amperage you must also reduce the size of your conductor if you are going to get the same degree of heating, and you must have the same heating if you want to keep the efficiency the same. From the foregoing it also follows that, in each case the other three terms remaining constant, the smaller the candle power or the higher the efficiency, the smaller is the filament. As a smaller filament is obviously weaker mechanically than one of larger cross section it follows that lamps of high volts, low candle power, or high efficiency, are relatively more fragile, both electrically and mechanically, than those possessing opposite characteristics. It is scarcely practicable to make carbon filaments for candle powers greater than one candle power per volt, particularly in the smaller sizes, no lamps are made for less than 3 volts, and 150 candle power is about the largest lamp desirable.

THE BASE: In the earlier days almost every manufacturer had his own base; in Europe somewhat the same state of affairs prevails to-day. Over here we some time ago settled down to three types—Westinghouse, T. H., and Edison—of which the latter is to-day being standardized by practically everybody. This result is being aided very largely by the introduction of the locking adapter, shown in Fig. 6, which is a new form of this little device that locks into a T. H. socket so that it cannot be withdrawn, thus permanently changing it to the Edison type. We can therefore expect that in a comparatively short time there will be nothing but the Edison socket in use throughout this continent. The benefits of this standardization, which affects not only the lamp itself but also the many different sockets and receptacles in use to-day, will be apparent to everyone.

STEM: The Stem or Stem Tube, shown in Fig. 7, is that part which contains the leading-in- wires, and is of course

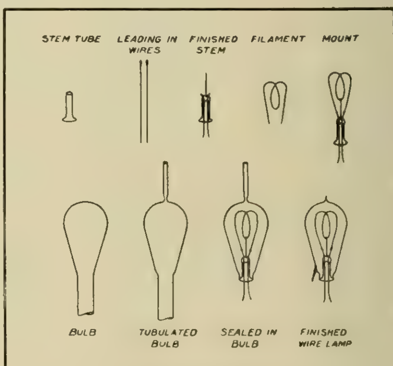


Fig. 7.—Lamp Parts.

made of glass. The lead wires are of copper except for a small part of their length at the end where they pass through the glass, at this point a small piece of platinum is put on, the object being to make an air-tight joint, glass and platinum having the same coefficient of expansion. At the same time as the leading-in- wires are put into place the anchor is put in. This is usually of nickel-plated iron wire, its function being to steady the filament so that it will not be so liable to breakage from excessive vibration or from touching the glass when hot. When the stem has had the filament mounted on to the platinum tips, for which purpose a carbon paste is used, it is called the mount, and as such is ready for insertion into the bulb.

THE BULB, shown in various stages in Fig. 7, is made of a very fine quality of glass, clear or colored as required, and one absolutely free from cracks or other flaws. It is extremely thin, about 1-100 of an inch, nevertheless it will stand quite a blow, and very successfully resists ordinary atmospheric pressure, which figures out on such a lamp as the 50 c.p. Meridian to about 125 pounds total. For special service under extra high pressure, such as that encountered in diving, or extra high temperature, like that in a baker's oven, it is frequently desirable to use a somewhat heavier glass.

The regular type lamp has a straight sided bulb in the medium voltage and candle power classes. For decorative work and mechanical processes there is an almost unlimited number of special shapes and sizes, such as the round bulb, candelabra, bung-hole or candle, telephone, etc., etc.

When the bulbs are received from the glass manufacturers they have the appearance shown in the first form illustrated

in Fig. 7. The first operation is to put the exhaust tube onto the large end and then cut off the neck to the required length; they are then known as tubulated bulbs. Next the mount is inserted through the neck and the joint between the bulb and the flare of the stem tube is sealed. The lamp is then exhausted by means of a vacuum pump, and is sealed off when that process is completed by heating the exhaust tube at a point close to the bulb, which leaves the familiar tip found on all lamps exhausted from this end. Lamps are sometimes exhausted at the other end, but the process is expensive and as a rule the trade will not stand the extra cost involved. You now have what is called a wire lamp and in that state it is ready for testing and basing, and then labelling and shipping.

There are, of course, numerous tests and inspections which a lamp has to go through both before and after the operations described above, the most important perhaps are those for vacuum, spotting, and voltage. The Vacuum Test is made by connecting the bulb and filament to the terminals of a powerful induction coil, the color and intensity of the resultant discharge between the filament and glass being a measure of the vacuum—practically no discharge indicating O.K., conversely a heavy discharge means a poor vacuum. Spotting is a test, as its name indicates, for spots in the filament. These arise from incomplete flashing, this latter operation occasionally failing to remove all the high resistance points, provided any such were originally present. When any of these still remain their natural tendency is to get hotter than the balance of the filament and thus to cause a quick burn out. However, by running the lamp at a low voltage so that the filament is only a dull red, they can be detected by an experienced eye and the lamp thrown to one side. The Test for Voltage consists of a photometer reading to find at what potential the lamp will give its rated candle power. At first sight it might be thought unnecessary to read but a small percentage of the lamps in each particular batch—just the same as you make a few briquettes of a certain run of cement or take occasional test pieces from the iron you are pouring—but such is not permissible because it is not known to the present state of the art how to make a filament come exactly to the desired rating; as a consequence you have to photometer every lamp you manufacture and find the actual voltage at which it will give the candle power for which it is designed. Assuming that you are working on the 16 c.p. 110 volt class besides obtaining these you will find a number of lamps in any given lot that will come 107, 108, 109 volts, and others 111, 112, 113 and 114; similarly the 104 volt class will produce say 100 to 108 volt lamps. Now this means that every lamp manufacturer must inevitably produce voltages ranging from say 100 to 130 volts, even though he try to make nothing but those for which the demand is greatest, say 104, 110, 115, 120 and 125 volts. Seeing then that production exists there must also be consumption in some way or another, and so that manager is wise who selects for his plant some potential other than 104 and 110, which apparently have got such a hold on the trade in this country. The advantages to the consumer are that he will on the average get a more closely selected lamp, obtain better deliveries, and, if he will go over his circuits and find the actual average potential and then use that voltage of lamp, better life and candle power results. This latter almost invariably turns out to be the case, because as a general rule such an inspection with a reliable instrument will reveal that the actual potential is considerably away from what it is supposed to be. If it turn out to be low your customers are not getting the light to which they are entitled, if high your lamps are being darkened and burnt out in far shorter time than should be the case.

There next comes up for our consideration the question of Operation or Lamp Service; it can most conveniently be discussed under the headings of Efficiency, Life, Trouble, and Renewals.

EFFICIENCY: This is the relation between the power consumed and the light produced, and is expressed by the term "Watts per Candle," usually written "w.p.c." High efficiency, that is, small energy consumption, simply means that you are burning your filaments at a comparatively high temperature; naturally this in turn means that that filament must give way sooner than one of lower efficiency, which is one operating at a lower degree of heat, in other words the higher efficiency lamp always has a shorter life under any given set of conditions than one which, while giving the same amount of light, does so at the expense of more energy, that is one of lower efficiency. Again, the higher the efficiency the shorter the life on mechanical grounds, as discussed in the last paragraph on filaments.

In the regular type medium voltage and candle power classes there are three standard efficiencies, 3.1, 3.5, and 4 w.p.c., or 49.6, 56 and 64 watts total per 16 c.p. lamp. The reason for the existence of different efficiencies will be evident when we recollect that the cost of light consists of two distinct factors—the cost of the lamp itself and that of the energy to operate it. Obviously, when your fuel expenditure is a minimum, as under such conditions as cheap coal, blast furnaces gases, a market for all your exhaust steam, water power, etc., etc., the low efficiency lamp will bring the light cost to a minimum; on the other hand heavy power costs make the high efficiency equipment the cheapest in the end. As a general rule the 4 watt lamp is too wasteful to merit consideration, and so unless your regulation is very poor you are confined to a choice between the other two. Assuming a life of 400 hours for the 50 watt and 800 hours for the 56 watt lamp, it will require two of the former to give the same life as the latter; they will save, however, 6.4 watts per hour, or for the 800 hours a total of 5.12 K.W. hours. Against this saving must be put the cost of an additional lamp, and assuming this latter at 17 cents it is evident that they exactly balance each other when 5.12 K.W. hours of power cost you 17 cents, or in other words, when power costs you $17 \div 5.12 = 3.32$ cents per K.W. hour. If your actual cost is less the 3.5 watt lamp is the cheaper, if more then the 3.1.

It must be noted that this method of figuring does not take into consideration the increased lamp capacity of a plant resulting from the use of a higher efficiency lamp, the fact that the higher the efficiency the sooner does the lamp burn out after it has got black, thus automatically ridding your system of lamps which are ready for the scrap pile, nor again that the higher the efficiency the better the quality of the light, that is, the greater its brilliancy or intensity and its whiteness. This difference in lights of equal candle power but from different efficiency lamps is frequently a source of contention, more particularly when working on colors than when dealing with black and white. The higher efficiency lamp *looks to be giving more light* than that of lower wattage, but this cannot really be so if they are of the same candle power, it is simply that the more pleasing quality is deceiving the eye into thinking that it is of greater quantity.

The efficiencies referred to above are those when a lamp is new; as it burns the candle power declines, and taking for illustration the point where it has fallen 20 per cent. we find that the wattage consumption during the same period has decreased approximately only 5 per cent., obviously the w.p.c. have changed very materially. This new efficiency obtained at the end of the life is known as Terminal Efficiency, that at the beginning is Initial Efficiency, the mean of the period in between is the Average Efficiency. Unless otherwise specified the initial efficiency is always the one considered, and is spoken of simply as the efficiency.

THE LIFE OF A LAMP, that is, its ability to continue giving light, is affected by a great many factors, such for instance as the voltage and candle power class to which it belongs, and again by the actual voltage at which it is operated, but before discussing them we should establish the meaning of the word, which in lamp practice can cover two distinct terms. In the first place you have the hours burning until the filament breaks down and the lamp refuses to burn any longer; this life to the burning out point is called the Average Life. Again you meet another condition which can best be described as follows, viz.: Taking a 16 c.p. 56 watt lamp left on the circuit until it burns out, we find that just before that point is reached it is giving say only 8 c.p., while the watt consumption has fallen but to 50 watts, or an efficiency of over 6 w.p.c. Now if 8 c.p. is sufficient light is it not obviously preferable to put in an 8 c.p. lamp, which will not only give that light for but 60 to 70 per cent. of the energy consumed by the old 16, but will also give you a light that will be of a 4 w.p.c. quality instead of worse than 6. From this we see that there is a point in the life of the lamp at which it is both economical and otherwise desirable

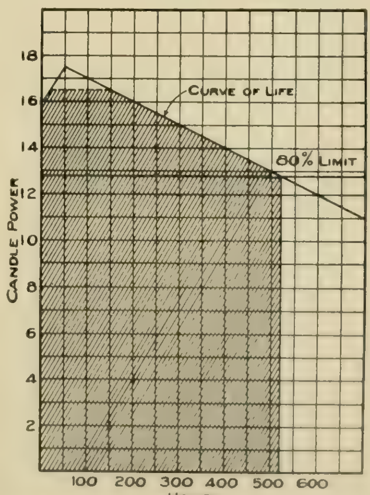


FIG. 8. LIFE CURVE AND CANDLE HOUR AREA.

to replace it, that point has been reached, according to present day incandescent lamp usage, when the candle power has declined to 80 per cent. of the original, or 12.8 c.p. for a 16 c.p. lamp. That is called the Useful Life, it is the only one of the two considered by modern lamp practice, and as such is called simply the life of the lamp. With good regulation a 16 c.p. 3.1 watt 100-125 volt lamp has a life of 400 to 425 hours, reducing the efficiency to 3.5 w.p.c. will double these figures, a 4 watt lamp will last four times as long.

The light emitted by an incandescent lamp grows constantly less and less for two distinct reasons; first because the filament burns away, thus increasing the resistance and consequently reducing the current, and secondly because the bulb gradually gets more and more coated by the deposit from the burning filament and thus passes less and less light. This fall in candle power is plainly shown by the curve of life in Fig. 8. The same cut also shows a shaded area which represents the product of the average candle power into hours of burning; this is known as the Candle Hour Area, and being a convenient method of expressing the performance of a lamp is frequently used in specifications. It is interesting to note from the curve that at first the candle power rises slightly, but as this is not a desirable feature, though not altogether avoidable, the lamp is not given credit, when calculating the candle hour area, for anything over 16.5 c.p.

Assuming equal efficiency a 32 c.p. should give just twice, and a 8 c.p. just half, the candle hour area of a 16 c.p. lamp. This, however, is not the case, as, if of the same efficiency, a 32 c.p. filament must have just twice the surface of a 16 c.p. Twice the surface means twice the amount of carbon dust coming off, and naturally to get the same darkening there must be twice the bulb surface to receive it. But a 32 c.p. has not got twice the bulb area of a 16 c.p.—it would be too costly and too unwieldly if it had—and so we find that relatively a 32 c.p. lamp darkens quicker than a 16, and thus gives somewhat less than twice the candle hour area. On the contrary, an 8 c.p. bulb has somewhat more than half the area of a 16, which means that on the average it gives rather more than half the candle hour area of that size. This relation between bulb and filament surfaces explains why lamps of the Meridian type do not exhibit any very marked darkening even if left until they burn out, from which it will be recognized that their life cannot be judged by the same standard as that applied to the regular bulb. It will further be evident from the same reasoning that 32 c.p. filaments in 16 c.p. bulbs must give very heavy blackening and thus short life.

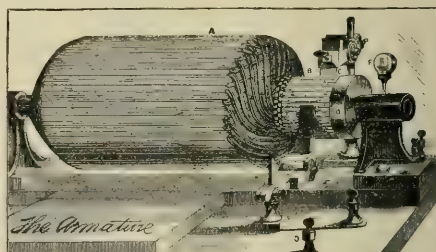
The life of an incandescent lamp is not affected by turning it on or off a number of times as opposed to continuous burning, nor by alternating as compared with direct current, nor, when burning on the former, by the frequency. It is affected by the candle power of the lamp, by the efficiency, and by the voltage, because these factors as they are changed one way or the other alter the diameter of the filament. As a small filament naturally has neither the electrical nor the mechanical strength of one of greater diameter, we find, as discussed under the heading of filaments, that high voltage, low candle power, and high efficiency lamps all tend to give shorter life than those of comparatively large candle power, low wattage, and medium voltage. The life is also very materially altered by the actual voltage at which you run; for instance, a voltage only 2 per cent. above that on which the lamp is supposed to be operated will lessen it by 30 to 35 per cent. The table shown in Fig. 9 covers this point in detail and should be carefully studied.

TROUBLE: This is naturally not a desirable thing to introduce, but as you will encounter it when dealing with incandescent lamps just as with everything else, it is well to be prepared. Practically the only form in which it will present itself to you is that of quick burn-outs and short life, lamps being brought in with the complaint that they burnt only a few hours, it is fortunate that from an inspection you can frequently tell pretty closely what is really the difficulty. First examine the filament, if the lamp did burn out the ends will be pointed and dull dead black in color, as opposed to the smooth steely grey of the balance. Failing these two evidences, the pointed end and the black color, but on the contrary finding the break square and grey to the end, you can positively assert that the lamp did not burn out, but was mechanically broken. On the other hand, presuming you discover evidence of burn-out, your next step in finding out why is to remember that the two most likely causes are bad vacuum and high voltage. A proper vacuum test involves the use of an induction coil, but you can get a rough idea of that in the suspect by comparing the vibration of its filament and that in a similar lamp known to be in good condition. If the vacuum be good the filament will vibrate more or less freely, depending upon the particular lamp involved, if the vacuum be bad the filament will be comparatively steady and come to rest almost immediately. Failing evidence of poor vacuum —and it must be borne in mind that this test is but rough and ready and therefore far from infallible—you would look at the color of the bulb, which is best viewed by holding it in front of a sheet of white paper. If this is appreciably darkened it means one of two things, either that the lamp gave normal life under normal voltage, or else abnormal life under abnormal voltage. You cannot get away from it, one or the other is correct, and your next course is to take a reliable voltmeter and go over the circuit. It is not sufficient that you get a statement from some one that the potential is O.K., but have it actually measured, the readings will frequently astonish you and disclose the definite source of the whole difficulty. High voltage is by far the most prolific source of lamp troubles, and consequently your potential should be rigorously kept within a small per cent. of normal, bearing in mind that it is not so much the potential at the power house which requires attention as that at the lamp itself; in other words frequent measurements all over the lines, both during light and heavy loads, and consequently a portable voltmeter, are absolute essentials to proper results from incandescent lamps. In this connection please refer again to Fig. 9 for a proper appreciation of the effect of high voltage on life. Occasionally you will find a burnt out lamp showing evidence of poor vacuum and having a star crack on the side of the bulb; this is due to static electricity having attracted the hot filament against the cold glass, this has cracked the latter at the point of contact, and air immediately rushing in has destroyed the vacuum. Static charges are due to various causes, but are usually most in evidence where there is considerable belting, especially in dusty situations, like cotton or planing mills. They are most frequently met in cold dry weather, under which circumstances the simple action of unwrapping the paper from a lamp is frequently sufficient to bring the filament hard against the glass. Lamps of large c.p. low voltage and low efficiency are not so liable to be affected by it as other classes because of their more rigid filaments. Moisture in the shape of water sprinkled on the floor, or a steam jet in the room, will usually remove all traces.

Volts	% Var from Normal	Candle Power % of Normal	Candle Power 16 cp Lamp	Watts per Can % of Normal.	Watts per Can 35 watt Lamp	Total Watts % of Normal	Total Watts 16cp 35w Lamp	Life % of Normal
Low Voltage	10	55	8.8	148	5.2	81	455	900
	9	58	9 3	142	5.0	83	46 5	710
	8	62	9.9	137	4.8	85	47.5	570
	7	66	10 6	131	4.6	87	485	450
	6	70	11.2	126	44	89	49.7	360
	5	75	11.9	121	4 2	90	50.6	290
	4	79	12.7	116	4.1	92	51.6	230
	3	84	13.4	112	3.91	94	52.7	190
	2	89	14.2	108	376	96	538	150
	1	94	15.1	104	3.63	98	54.8	125
Normal		100	16	100	3.5	100	56	100
High Voltage	1	106	17.0	96.5	3.4	102	57.3	81
	2	112	17.9	93	3.3	104	58.3	66
	3	118	18.9	90	3.2	107	597	55
	4	125	20.0	87	3.1	109	60.8	44
	5	132	21.1	84	2.94	111	620	36
	6	139	22 3	81	2,84	113	633	29
	7	147	23.6	78	2.75	116	647	25
	8	155	24 8	76	2.66	118	66.0	20
	9	164	26 2	74	2.58	120	67.4	17
	10	173	27.6	71	2.5	121	688	14

FIG. 9.—VARIATION OF CANDLE POWER WATTAGE AND LIFE WITH CHANGES IN VOLTAGE.

RENEWALS: There are as you know two distinct methods of renewing, that by which you charge your customers for the new lamps, which means renewing when burnt out, and the free renewal system, which means renewing when the lamps have reached the end of their useful life. The first means lamps bought here and there all over the country in an effort to get a cheap equipment, which means usually a poor one, it means lamps of low efficiency, thus if you are running a meter system (which by the way you should be if you are not) your bills are high and your customers are dissatisfied, if operating on a flat rate system your coal pile is suffering. In the one case your lamps are black and giving next to no light, consumers already on your books want to get off, and nobody else is anxious to take their places; in the other your light is always bright and attractive, and your accounts are cheerfully paid. Lose no time in introducing the free renewal system, it will pay you several times over, seizing such an opportunity as a proposed reduction in rates, or the introduction of meters, as a chance to make the change as a concession in



THE ARMATURE OF THE DYNAMO SUPPLYING THE LAMP SHOWN IN FIG. 1.

lieu of the one or a step in keeping with the progress indicated by the other. You own and manage the generators and the lines, and would not think of allowing each customer to handle them at will, why do so with the most important part of the system, that which everyone sees and by which they judge you, the lamp itself. You regularly clean and overhaul your engines and boilers so that they may be repaired and replaced before they break down and absolutely cannot run any longer, why not give at least a part of the same attention to the lamps, to which after all the engines and boilers are but as a means to an end. Why worry about 2 per cent. less efficiency in a transformer, and swallow without question a 10 to 12 per cent. increase in the consumption of the lamps themselves, why cheerfully trim an arc lamp every 100 hours, and yet consider it unreasonable that the incandescents should ask to be trimmed every 700 to 800, why have a meter department, and yet not one single man who is really responsible for the incandescent lamps on your circuit? As has been previously pointed out, the incandescent lamp is the main source of central station revenue and that part of the system which your customers see and use, the part by which they judge you; any defect or neglect in it is felt right back to the coal pile—is it not in order that more of the careful engineering and energetic management which is given to engines, generators, lines, and transformers should be given to that part of the system to which they are all tributary and without which they are just so much waste effort, the Incandescent Lamp.

THE ECONOMY OF ISOLATED PLANTS.

By K. L. Aitken.

The first question which presents itself when giving consideration to "isolated electric plants" is the exact meaning of the phrase. At first sight this would appear a very simple matter, but upon going into the question, complications present themselves which tend to confuse and make more difficult an interpretation of the words.

The "central station" according to the general understanding, consists of a power house which supplies energy in an electrical form to a comparatively large number of consumers, whose places of business are widely distributed. The isolated plant is primarily an equipment installed by an individual or company to supply his or its lighting and power circuits. There are, or course, central stations which are laid out on a small scale, and on the other hand, isolated plants exist which are very much larger than even central stations of average size. Such isolated plants may supply energy to a large number of buildings all of which are owned by and are units of one commercial enterprise. Under such conditions the equipment can still be classified under the term isolated plant; although the amount of power which it supplies and the area distributed over greatly exceed the energy and distribution of the central stations which can be found in our towns and even cities. Consider that a company has a large factory and has installed therein a complete generating equipment, and that near this factory there is a small concern requiring electrical energy. The larger factory agrees to furnish power to the smaller concern upon either a flat rate or meter basis. Then the question arises, does the large plant, by this action, lose its identity as an isolated equipment, and become a central station? If all the power generated by this plant be consumed within the building which contains the equipment, and one floor or room in this building is rented to some other person or concern than the owner of the building, and power and light is sold to this person or concern, does this action make the equipment a central station?

From the above it will be seen that it is a difficult matter to differentiate between the two classes of equipments—the place where the line should be drawn is not clearly defined. However, so far as this paper is concerned, I am going to deal with the smaller class of isolated plant which supplies power and light only to the building which contains the equipment, irrespective of the number of individual consumers in such building, and shall consider the economy of such plants in relation to the cost of buying light and power from a local central station. In other words, I shall assume the position of the purchaser of light and power who wishes to ascertain whether or not it would be a paying investment to install a plant of his own.

The information embodied in this paper is based upon reports which I have submitted covering the various phases in which the problem has been presented to me, both in the City of Toronto and in other localities.

People have often come to me and asked, in a very indignant tone, why they have to pay more per kilowatt-hour for their lighting than for their motors; having been informed upon good authority that there is little or no difference between the kinds of electricity supplied for both purposes. For instance, they will be paying three cents for their power, and ten cents for their lighting. This brings forward a phase of the isolated plant question which is really of greater importance than size—I refer to load factor. This point I intend to take up later, and will therefore give it but little attention now. As an illustration, however, of the reason for this great difference, in prices of light and power, I [illegible] the general condition of things which can be found in almost any central station. [illegible] company has a constant ten [illegible] horsepower, and, that to carry this load they have boilers, engines, and generators, with a [illegible] thousand horse. Thus, the equipment will be running at full load throughout the entire day, and therefore at its point of highest efficiency. The [illegible] hour day will be ten thousand horsepower-hours. Now let us consider the lighting question [illegible] same company supplies to the power consumers a maximum of one thousand horsepower [illegible] means that the equipment for supplying [illegible] have a capacity of one thousand horsepower, [illegible] experience has been that this load is carried on the average not more than two hundred hours per year. As this season will be in the fall, winter, and spring of the year, we can assume that this load is distributed over approximately one hundred and fifty days, or is carried on an average an hour and twenty minutes per diem. This means that the daily output of this thousand horsepower lighting plant is only thirteen hundred horsepower-hours. Summing the matter, we have two equipments, each of one thousand horsepower capacity, one supplying ten thousand horsepower-hours per day, and the other only thirteen hundred. Therefore, it is not difficult to understand from the foregoing why the energy for power will cost three cents, and the energy for lighting ten cents. If we assume that the above prices are per horsepower-hour for the sake of argument—they are really per kilowatt-hour—we find that the income per day for power is $300, and the income for light is $130, and this latter only for one hundred and fifty days per year. If we average this lighting figure for the whole year, we find that the daily income is in the neighborhood of $65, which certainly contrasts very unfavorably with the $300 daily income from the power equipment. While the interest, depreciation, and insurance—or constant items—will be the same for both plants, the coal, labor, water, oil, etc.,—or variable items—will be reduced, but not nearly in the proportion by which the output of the lighting generators is reduced. Upon going into the matter very fully we find that the relative figures of three cents and ten cents are very close to what they should be.

From time to time, I have had occasion to visit people who have isolated plants, and in reply to my inquiries have been informed that the operation of the plants is very satisfactory. Upon endeavoring to obtain further information concerning the actual cost of operation, I have been advised that the installation of the plant has made a very material saving over the cost of electrical energy as it was purchased from the local central station. These matters have always interested me, and in several instances I have gone into the propositions simply to get information for my own use, and I must say that the results have been surprising. One of my friends advised me that by installing his plant he had not actually decreased the cost of his lighting and power, nor had he increased the item, but that with his plant installed he was using about double the amount of energy, without additional cost. I went into this particular case very carefully, and ascertained that the statement pertaining to the doubled consumption was quite correct, but I found that the cost per kilowatt-hour for the plant was over eight cents whereas the price paid to the local power company had been six cents.

To be quite frank, I have found very few plants which fulfil my understanding of the word economical, and in every case, the owners of such plants had told me that the installation had proved a decided success. All this leads me to draw certain definite conclusions, namely, that where uneconomical plants have been installed, the owners know that a mistake has been made, and are not willing to admit it, or else they have no idea whatever of the many items which must be charged against the operation of a plant.

Boilers, engines, piping, condensers, generators, building, heating, etc., etc., are all important features in the economical operation of any equipment, and must not be lost sight of; but over and above all else stands the one item of load factor.

The best condition is to be found in a manufacturing establishment, having an all-day power load which is fairly steady, and a lighting load which is small in comparison with the power required. Of course, if the lighting could be eliminated entirely, the load would be an ideal one, but such a condition is seldom found. Were this the case, the average economy of isolated plants could be materially increased.

Where the amount of energy required by lights is large compared to that taken by motors, the plant [illegible] a capacity sufficient to handle the combined [illegible] and therefore the load factor of the system will be low, and the daily output in kilowatt-hours will be very much less than the possible all-day full-load output. In contrast with that which I have designated [illegible] condition we find the worst in hotels [illegible] Here the service must be for twenty-four hours, and for about eighteen hours of this period the [illegible]

will not average more than five to ten per cent. of the rated capacity. It is this low load operation that is responsible for the poor economy of many of the plants installed to-day. One instance of this is to be found in a certain Toronto plant. Two generators of the same size, each direct connected to an engine, are being run twenty-four hours per day, one to supply lights, and the other a number of elevator and other types of motors. This plant has been very badly laid out, and therefore cannot be taken as a fair example, but I am incorporating some figures taken from it as an illustration of the inefficiency of low load operation. The lighting machine supplies about 1,925 kilowatt-hours per week, and the power machine about 385, or approximately 20 per cent. of the energy used for light. On actual test of this equipment, I found that the coal consumption of the power machine was about 60 per cent. of that of the lighting machine. I might say in connection with this plant that both machines are running very much under their rated loads, the average for the lighting machine being 29 per cent., and for the power machine only 5.8 per cent. The power machine carries a normal load of but a few horsepower, but when the two elevators, which it supplies, happen to start at the same instant, the kick runs up as high as twenty-five horsepower. With the lighting machine the general conditions are better. For eighteen hours, a load of about 7.5 kilowatts is carried, and for the remaining six hours from 30 to 40 kilowatts. This plant, as I mentioned previously, is badly designed, and besides has a very unsatisfactory load to handle. The combination of the two produces a result far from gratifying to the owners.

In contrast to the above, I wish to bring to your attention an equipment installed in a Toronto factory. There is one 50 kilowatt generator, and this handles both the lighting and power. The possible maximum for lighting amounts to about 15 kilowatts, and for the power we have a total of 80 horsepower of motors, which take from the generator about 15 kilowatts, and give an exceedingly steady load. The lighting load is really very small, the highest consumption yet recorded from this source not exceeding 7 kilowatts, and rarely going so high. Here we have a plant running ten hours per day under a load of but 30 to 40 per cent. of its normal capacity, and while the yearly output is less than one-half of that of the plant previously mentioned, the cost per thousand watt-hours is considerably lower. I ran this plant for almost eleven months, during which time the output was recorded by watt-meters, and a careful record was kept of all operating expenses. The total output during this period was about 37,000 kilowatt-hours, and the cost per thousand watt-hours was but a trifle over four cents. The generator is now considerably larger than is actually required, but the total equipment of machinery throughout the building has not yet been installed. When this plant is running up to its full capacity, I am confident that the total operating cost per kilowatt-hour will be lower than three cents.

The foregoing figures are taken from tests of plants in actual operation. In each of these two cases, I figured the operating cost on paper before making the test itself, just to see how close such estimates could be made, and the results were exceedingly satisfactory. The other figures which I am incorporating are estimates concerning plants now being installed, or which are still on paper. However, I am reasonably sure that they are of equal value to those obtained by actual test.

Some time ago, I had charge of a proposition where it was proposed to install a small plant. The size of the generator in this case was 30 kilowatts, but the load factor was so bad that although we have our boiler installed and also have in our employ a fairly well paid engineer, the estimated cost per kilowatt-hour was almost six cents. The proposition was therefore dropped. If sufficient additional power load could have been secured for this equipment (the load is all lighting with the exception of one small elevator motor) the operating cost could have been reduced to below three cents.

As all the foregoing applies to very small equipments, I wish to present figures concerning larger plants, to show that the feature of load factor applies in such cases also. There is a general notion that the large plant is inherently a good proposition, it being possible to employ higher grade men, use more efficient boilers, and possibly run compound condensing engines. While this is perfectly true, if taken generally, still it does not necessarily follow that the large plant will be a paying proposition. The cost of energy per kilowatt-hour will doubtless be less, but at the same time must be considered the fact that if this energy were purchased from the local central station, the large consumption would command a very favorable price.

The first figures which I am going to give pertain to a building which requires a twenty-four hour service, six days per week. For twelve hours on Sunday, the entire equipment is closed down. From ten o'clock at night until seven the following morning, the load runs slightly less than 50 kilowatts. From seven in the morning until the evening lighting comes on, the load amounts to 150 kilowatts, and when the lighting is added to this, the total is brought up to between 500 and 600 kilowatts. This total is on for a couple of hours, and gradually falls off until the 50 kilowatt point is reached about ten o'clock. For handling this load, three units are to be installed, one 50 kilowatt, one 200 kilowatt, and one 300 kilowatt. Each generator is direct connected, the small machine being operated by a simple high speed automatic engine, while the two other machines are operated by tandem compound high speed corliss valve engines. All three machines may be run either condensing or non-condensing, depending upon the season, and the amount of exhaust steam required for heating the building. The boiler equipment will probably consist of four 200 horsepower units, either of the internally fired or water tube type.

The load factor of the plant can hardly be termed as very good, but still the operating cost is not excessive. For a yearly output of approximately one million kilowatt-hours, the cost per thousand watt-hours will not exceed two cents, and may be a trifle lower than this.

I have one more plant upon which I wish to present figures, and its load is of a peculiar nature. For twelve hours per day, every day in the year, it carries a full load of four hundred kilowatts. There are two 200 kilowatt generators, each direct connected to a tandem compound high speed corliss valve condensing engine, and besides this there is a third unit of 200 kilowatts capacity as a spare. Two 300 horsepower water tube boilers, carrying a pressure of 150 pounds, will supply the two running units, and there will also be a third boiler of 300 horsepower as a spare. The engines will always run condensing.

I have taken up roughly the question of superheating the steam for this plant, but at the present time, am not prepared to make comment on this feature. However, it is doubtful if superheating be employed for any other purpose than to supply the engines with perfectly dry steam, and for this purpose a small percentage of superheat will be sufficient.

The annual output of this plant will be about a million and three-quarter kilowatt-hours, and the cost per thousand watt-hours approximately one and three-quarter cents. In spite of the very favorable load factor, the cost of operating is not as low as might be expected, when comparison is made with the figures given for the previously mentioned plant of large size; but in the former case, a large volume of exhaust steam is required for heating and this estimated heating expense is deducted from the gross operating cost of the plant, and also there are no spare units installed. In the latter case, it is of the utmost importance that continuity of service be maintained, and this has led to the installation of 50 per cent. reserve capacity. And besides, there is no heating whatever in connection with the equipment.

This heating question is a very interesting one, and it is quite possible that in the future steam distributing systems will be installed in our Canadian cities, on the same scale that the idea has been adopted in the States. While running condensing means a very material saving in plant operation cost, still the revenue which can be obtained from the sale of exhaust steam for heating purposes will really effect a much greater economy. In scattered districts this method of heating is not very desirable, but where the power house is in a congested district the question of going into the steam heating business is very worthy of consideration.

The installation of reserve units in isolated plants is a problem requiring much study and experience, for the greater the unused capacity of the plant, the lower will be the economy. In a recent installation outside the City of Toronto, the steady power load amounts to 20 kilowatts, and the lighting load to 30 kilowatts. To take care of this, two units have been installed, one a 25 kilowatt machine, and the other a 35 kilowatt. To carry the combined lighting and power loads, both machines will be required, but in the event of an accident to either unit, the majority of the motors can be kept in operation by either generator, and therefore such an accident will not mean a complete shutdown. This arrangement is one which will have fairly good efficiency, and will minimize the chances of a complete closing of the factory.

In an isolated plant, the cost of distributing is generally very much less than in the case of a central station, and therefore such a plant has one very favorable feature on its side, when considering the question of comparative prices. I might say at this point that the figures of costs which have been given in this paper are costs at the switchboard, and that no consideration has been given to distributing, it being assumed that the cost of distribution would be the same whether power were made or bought.

In summing the isolated plant question, I would say that many equipments have been installed which really have not deserved more than passing consideration, and on the other hand, there are many situations where a private plant would mean a material saving. Load factor is the item requiring greatest consideration, and it is safe to say that wherever this is in anyway favorable, the installation of a private plant will effect a material saving over the cost of purchasing energy from a steam driven central station.

I thank you, gentlemen, for your attention.

NOTES ON THE POLYPHASE INDUCTION MOTOR.

By H. A. Burson.

It is the purpose of this paper to briefly set forth the characteristics of the Polyphase induction motor, the various types and the classes of work to which each are suited.

The induction motor is essentially a transformer. At start it is a static transformer, and when running, is a transformer with the line frequency in the primary, and a frequency equal to the slip in the secondary. The static transformer is designed with as little leakage as possible. This is accomplished by properly winding and grouping the coils, and making a good magnetic circuit. The magnetizing current is small and the power factor high even at light loads. In the induction motor, on the other hand, the leakage is comparatively large. The primary winding

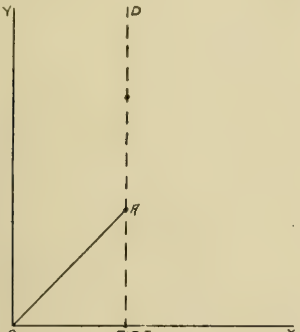


FIG. I.

is on the stator core and the secondary winding on the rotor core. Between these cores is an air gap which increases the leakage and the magnetizing current ; and the power factor at no load is practically zero.

The vector diagram of a static transformer without leakage is as shown in figure I. If OA represent the no load current vector, angle AOY being the angle of lag, as the non-inductive load increases, the power factor of the primary will increase, and the locus of the point A will be the line BD parallel to OY. In the induction motor, however, owing to the leakage, the locus of the end of the current vector is not a straight line but a circle as shown in figure II. OA is the no load current, OA^1 is its wattless component and AA^1 is watt component. As the load increases on the motor the end of the current vector moves along the circle ABK, centre G. It will be seen at a glance that the power factor does not continue to increase with the load, as in the case of the static transformer without leakage, but reaches a maximum at the point C

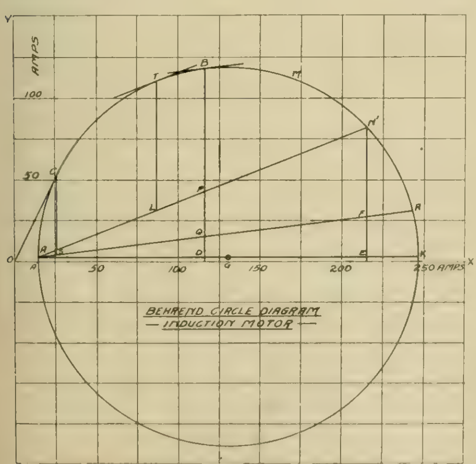


FIG II

and then begins to decrease. It will also be seen that if the value of OA be decreased for the same diameter of circle, or the diameter of circle be increased for the same value of OA, the maximum power factor will be increased. The value OA/OK is known as the leakage factor, and to keep it as low as possible is the aim of the designer.

This leakage factor depends upon the design of the machine. Mr. Behrend in his excellent book on the induction motor, states that it varies directly as the air gap, and inversely as the pole pitch. He gives the formula $\sigma = C\frac{\Delta}{T}$ where σ = leakage factor, T = pole pitch, Δ = air gap, and C a constant depending upon the type of machine. Much has been written of the value of this constant C, and several tables have been compiled. The writer considers that for a certain type of a machine, its value depends upon the pole pitch and the width of core, and has found that the formula to give most consistent results is $C=\frac{K}{\sqrt[3]{TB}}$. Where B = width of core, T = pole pitch, and K = constant.

Nothing has as yet been said of the motor losses. These are the iron and copper losses. The former is approximately constant, and is taken into account by the energy component of the no load current AA^1. The copper losses, on the other hand, vary as they square the current load and it may be proved that the ordinates between the lines AK and AR represent the stator C^2R loss, and between AR and AN the rotor C^2R loss.

It is now a simple matter to determine the characteristics of the motor. Take for example the point B. The current per phase is OB. Its energy component is BD, and hence the power factor is BD/OB. The total losses are represented by PD, the total input by BD, and hence the output is BP, and the efficiency is BP/BD. The slip, as may be proved, is equal to rotor C^2R loss divided by the total input into the rotor, and is therefore PQ/BQ. These quantities may be found for several points and complete performance curves plotted as shown in figure III.

The point N is the position of 100 p. c. slip, and hence ON is the starting current per phase at normal voltage, and NF the starting torque. It will be seen that if the rotor resistance be increased to raise the line AN to the position AN^1, the starting current is reduced and the starting torque increased. The maximum starting torque is when the line AN takes the position AB. Increasing the rotor resistance however increases the rotor C^2R, and hence increases the slip and decreases the efficiency at full load. Hence the starting torque allowable at normal voltage depends upon what conditions must be met as regards efficiency and slip.

The maximum overload which the motor will stand before falling out of step is represented by TL. To increase this value for a given machine the rotor resistance may be decreased or the diameter of the circle increased. The former means a decrease in starting torque and the latter an increase in the no load current and a decrease in the full load power factor. As Mr. Behrend remarks "A design is more or less of a compromise, and the best design is that which combines the greatest number of advantages with the least number of drawbacks."

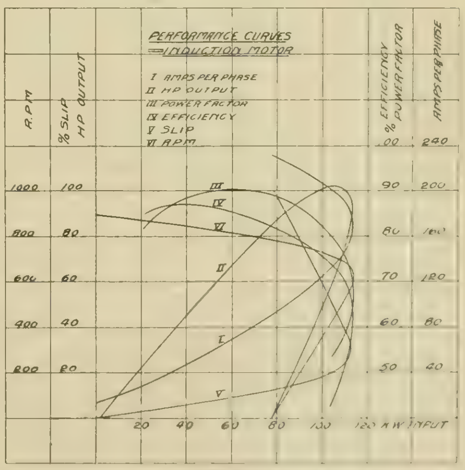


FIG. III.

Again referring to figure II it will be seen that the starting current at normal voltage may be from four to six times full load current. In a motor with constant rotor resistance, that is a squirrel cage motor, this value may be cut down by the use of an autotransformer to reduce the applied voltage at starting. The effect of this on the circle diagram is to reduce the magnetizing current and circle diameter approximately as the reduction in the applied primary voltage. The starting current will be reduced proportionately as the voltage, but the starting torque as the square of the voltage. If a small starting torque is required, such as when the motor starts light, the starting current from the line may be reduced to full load current. If on the other hand a large starting torque is necessary, as when motor starts under load it is impossible to reduce the starting current materially.

To meet the conditions of a high starting torque and a

low starting current, a motor with coil wound rotor and variable external resistance in the secondary is used. The circle diagram for such a motor does not change with the exception of the position of the line AN. At start sufficient resistance is introduced to cut the primary amperes to value, for example, OC. The starting torque is represented by CS. As the motor speeds up resistance is cut out, and when maximum speed is reached the rotor windings are short circuited. It will be seen that with such a motor it is possible to combine high starting torque, low starting current and high efficiency under load.

The question of squirrel cage motors versus external resistance motors is much discussed. In Europe the latter are largely used, while in this country the former are in preponderance. The advantages claimed for the squirrel cage type are, simplicity of operation, small cost of repairs, and cheaper first cost. The disadvantages are large starting current under load, and large slip if high starting torque is required. Small motors which will not be required to start under too heavy load, should be of the squirrel cage type, while for those of larger capacity the external resistance type is preferable. It is a question for the purchaser to decide, taking into his starting conditions and power contract.

In this connection the writer would like to draw the attention of Engineers to the issuing of induction motor specifications. It must be remembered that power factor, efficiency, slip, starting torque and overload capacity are, to a certain extent, interdependent. For example, to specify that a motor shall have a slip at full load not to exceed 3 p. c. and a starting current not to exceed twice full load current, the motor to be started under load, is, as has been shown, to say the least, inconsistent.

SUGGESTIONS FOR STEAM ECONOMY.

By Wm. McKay.

Almost every engineer and electrician is familiar with the fact that the majority of steam-power plants are not operating under the most economical conditions. In some cases this is due to the plant having been built up piecemeal as the requirements developed and in other cases it has been found difficult to determine the amount of power that would actually be required until after the plant was completed. If the consulting engineer could be informed, or could determine in advance the exact requirements for the present and future, it would be comparatively a simple matter to design the plant with fair accuracy as to the size and number of units, types of engines, boilers, and other details.

Although it is difficult to give any general information on this subject which will be of use or interest in the great variety of particular cases in which the members of this associatian are interested, it may be of some interest, and possibly of assistance to those who are managing or operating power plants, to discuss some of the principles upon which economy in the use of steam depends.

Beginning with the boiler, which is the first step in the production of power from fuel, it may be laid down as a good rule that it is more economical to use boilers of reasonably large size than to subdivide into a larger number of s all units. The length and area of grate that can be conveniently fired or kept evenly covered with coal is, perhaps the limiting feature, if hand firing is to be used. Working from this rule, a grate should not be over seven feet long or more than five feet wide, which would give 35 square feet of grate surface. The quantity of coal that may be burned on such a grate varies widely with the kind of fuel and strength of draft. Using bituminous slack coal of fair quality, with good natural draft or moderate-induced draft, it should be possible to burn 25 lbs. of coal per square foot of grate per hour. or 875 lbs. of coal per hour, and if this coal will evaporate say 8 lbs. of water per pound of coal, the boiler, if constructed with heating surface in proper proportion, would evaporate 7,000 lbs. of water per hour, which would be equal to a little over 200 standard boiler horse-power. In order to give good economy, the boiler should have from 2,000 to 2,400 square feet of heating surface to evaporate this quantity of steam economically. The return tubular boiler, on account of the amount of tube surface in proportion to the direct surface exposed to the fire, should have not less than 12 square feet per horse-power; the water tube type from 10 to 11, and the internally fired type, which has a larger amount of direct heating surface in the furnace and tubes than either of the others, should have 9 to 10. If the grate surface is larger than that described, probably the grate will not be evenly covered with coal, or the fire will be dead in spots, so that too much cold air will pass through.

The economy in burning fuel is a matter requiring great skill and experience, and depends entirely upon the evenness, thickness and condition of the fire, which controls entirely the air supply and, therefore, the perfection or imperfection of the combustion, and I would say just here that there is very little use in "spliting hairs" over a quarter of a pound of steam consumption of the engine, while the fireman may be losing ten times this quantity of fuel from inefficient boilers or poor firing.

I fear it is too often the case that the demand for increased horse-power are met by grate surface too large in proportion to the heating surface of the boiler or forced draft, and too little attention is given to careful firing, with heating and grate surfaces in proper proportion to give best economy, and frequently a great deal of money is spent in obtaining high-class engines and condensers, whereas the principal loss is in the boiler and fire room.

The question is often asked whether in case of installing a certain horse-power of boilers, say 300 horse-power, it would be more economical to have three boilers of 100 h.p. each or two boilers of 150 h.p. each. I would say by all means have the two larger units, as it will always be found that the larger boilers have less radiation, less air leakage and better combustion than a corresponding horse-power in small units. If it is necessary to have a spare unit for cleaning, let there be another one provided of the same size.

In regard to the pressure to be carried: It is well known that a high pressure gives a greater amount of expansion and better economy in proportion to the fuel burned. Even with simple engines in which it is not possible to obtain the full advantage of expansion, the high pressure of steam, which is drier and contains a larger number of heat units in proportion to the volume, gives the best results. I think every boiler should be designed for not less than 150 lbs. pressure per square inch. Even if it is not possible to utilize the full pressure, the boiler will be stronger, last longer and a better investment in the long run. In this respect, the water tube or some form of internally-fired boiler in which the shell plates are not exposed to the high temperature of the furnace, are certainly safer than the horizontal return tubular boiler, because for large units intended to carry high pressure, the shell plates and seams must be of considerable thickness, and being directly exposed to the hottest part of the fire, are almost sure to give trouble, especially if there be any scale or sediment in the water which is liable to settle on the bottom directly over the fire.

As to the economy of various types of boilers, experience shows that any of the standard types, horizontal return tubular, water tube, or internally fired, if they are designed with proper proportions of heating and grate surface, give about the same evaporation per pound of coal, provided they are in good condition and clean both on the fire and water surfaces. While the externally-fired boilers, either of the return tubular or water tube type, are said to have some advantage in combustion, on account of the heat of the brick furnace, they are subject to losses which are more serious, in the way of air leakage and radiation. Tests made at the Ohio State University, by Professor Hitchcock, show that the brick-setting of boilers continues to absorb heat up to 72 hours after being started, and that the average waste of heat in brick furnaces is about 8½ per cent. As the members of this association well know, the repairs and cost of keeping up brick furnaces is considerable, and as a result of deterioration there is more or less air leakage through the brickwork going on constantly. In this respect, the internally-fired boiler has a great advantage over return-tubular or water-tube boilers with brick furnaces, as it will be just as efficient after continued use as when first started.

In any type of boiler it is of great importance to keep the tubes and other surfaces free of soot and scale. Otherwise, a large loss may be sustained. I think it is a mistake to depend entirely on the steam blower or tube cleaner, which only removes the loose soot, a scraper being necessary for occasional use to free the hard scale, which will in time accumulate on the fire surfaces. It is necessary to point out that scale, or worse still, oil on the inside of a boiler may be a source of great loss, experience having proved that even a thin film of oil will so prevent the transfer of heat that the plates or tubes will be burned in a very short time. Nothing but pure water should be used for making steam, and the practice of making the boiler do duty as a water purifier as well as a steam generator cannot be too strongly condemned. If the owners of steam plants could be made to realize that a very small deposit of soot on the outside and scale on the inside means a loss of from 10 to 20 per cent. of the total fuel consumption, costing, perhaps, thousands of dollars per year, they would be convinced that it would be much cheaper to spend money in purifying apparatus, so that the scale or sediment will be removed before the water is fed to the boiler.

The next step to be considered is the heating of the feed water. This may be accomplished in two or three ways: First, by means of the exhaust steam, which, coming from a non-rondensing engine, is capable of heating the feed water to 212 degrees and of saving say 12 to 15 per cent. as compared with feeding cold water. For large plants where it would pay to use induced draft to

make up for the loss in temperature of the chimney gases, which produce the draft, it will undoubtedly pay to use an enonomizer, but as this apparatus is expensive both in first cost and up-keep, the amount saved in utilizing the waste gases from a small plant would probably not offset the outlay. The closed type of feed-water heater is about as efficient as the open type, provided the water is pure and it avoids trouble from pumping hot water, but the open type is frequently made use of to assist in purifying the water and, if properly managed, may give good service in that respect. For condensing engines, a primary heater of the closed type may be installed between the engine and condenser, which will help to condense the steam and heat the feed water to a low temperature, say 130 to 140 degrees Far. A secondary heater, either of the closed or open type, may be used to heat the feed water to a still higher temperature, say 212 degrees, by the use of the exhaust from the feed and air pumps, which cannot be used more profitably than in this way, as all the heat is returned to the qoiler.

In regard to the type of engine used for the plant: If the size of plant is sufficient, and the work comparatively steady, the highest possible results may be obtained from compound condensing engines using the highest possible pressure of steam, but under other conditions, such as variable load, low pressure of steam, it may be quite possible that the simple engine will give better results and cost less for repairs. With low-steam pressure, non-condensing, there is certainly nothing better or more economical than a single-cylinder Corliss engine where it can be installed to advantage. In the case of direct-driven electric units of small size, it is necessary to use high or medium-speed engines, both on account of the loss in friction that would come in if countershaft and belting have to be used and because the higher speed machines will give the best regulation. For small units up to say 75 or even 100 horse-power, there is nothing better than the modern high-speed, automatic engine, provided it is of good design, not overloaded and not overspeeded. A well-designed engine with 12-inch cylinder and 12-inch stroke, which is usually run at 275 to 300 revolutions per minute, and made to develop from 75 to 80 horse-power, if arranged to run at say 225 to 250 revolutions per minute and to carry 50 or 60 horse-power, will be as serviceable and give as good results as any type of engine of the same horse-power under ordinary conditions non-condensing, and if the work is variable, requiring quick, close regulation, such as driving electric generators, where the load is irregular, say for supplying current to electric lights and electric elevators, the short-stroke, single-valve type of engine has great advantages.

As illustrating the small wear of high-speed engines under favorable conditions, a Robb-Armstrong engine of 12-inch stroke, which has been running at 275 revolutions per minute for electric lighting for twelve or fourteen years, shows only about two-thousandths of an inch wear of the journals, and six-thousandths of an inch wear in the shaft bearings.

Unfortunately, this class of engine is so frequently overloaded and overspeeded that it gives poor results and gets a bad name, whereas the Corliss slow-speed type of engine is limited both in the matter of speed and horse-power, because the cut off of the single-eccentric type will not go much beyond half stroke, and in that way the engine is saved from overloading and buse, and this is, perhaps, one of its many advantages. A compound engine is not suited to low pressure or irregular loads and the extra cylinder and complication of parts is a great objection under such conditions. When a condenser is used, even with low pressure and somewhat irregular loads, it may be employed to advantage and with high pressure, say from 125 to 150 lbs. or over, the non-coni densing compound will give the best results, unless the load is very irregular and running to light loads a large part of the time.

The question is sometimes asked whether it pays to reduce the pressure when the load is light. From my experience, I do not believe it pays to reduce the pressure on the boiler, excepting in very extreme cases, but if it can be done by throttling before the steam reached the cylinder of the engine, it would be an advantage, because this retains the heat units due to the higher pressure in the steam and the throttling has a slight super-heating effect. As a matter of fact, tests made by Willins & Robinson, of England, go to show that for light loads and high pressure, a throttling engine may do even better than automatic cut off. The ideal arrangement is to throttle the steam for light loads up to say near quarter cut off, and after that, for heavier loads, allow the variable cut off to come into play. This practice has been carried into effect by the design of Mr. E. J. Armstrong, in which he arranges the shaft governor so that there is negative lead up to nearly one-quarter cut off, after which the lead becomes positive, and this has the effect of throttling the steam for the earlier loads and undoubtedly gives better economy, in addition to making the engine run more quietly.

Another source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

In general, it may be said that the principal causes for loss in steam plants is the use of engines which are overloaded or unsuited to the conditions of work, undersized, or badly-arranged steam and exhaust pipes, and the imperfect condition and poor operation of the boilers. In many plants, exhaust steam, which might be utilized for heating, is wasted, and in others, where the exhaust steam is utilized for heating, power is wasted by excessive back pressure. The most economical use that exhaust steam can be put to is for heating, because all the heat units are made use of, but it should be done without back pressure on the engine, by means of a vacuum system to draw the steam and water through the heating pipes, otherwise there will be a loss both of fuel and power, due to the engine working under imperfect conditions.

THE SELECTION AND MAINTENANCE OF SERVICE METERS.

The legitimate revenue of a company supplying electrical energy which is measured and charged for by meter, is determined only when such meters are intelligently selected and properly maintained.

Service meters must be selected with due regard to their mechanical construction, electrical characteristics and the installation to be metered; else their accuracy cannot be maintained and their operations will be short-lived.

MECHANICAL CONSTRUCTION.

A close inspection and, where possible, a test should be made of all parts which might affect the continuous operation of life accuracy of the meter. The inspection will include the form and number of terminals; the insulation between the terminals and to ground; dust-proof features weight of the moving element; bearings; style of dial; adjustments, mechanical and electrical.

The form of terminal should permit ease of installation insure good electrical contact and make it difficult to tamper with the registration of the meter. The terminal proper should be protected by an insulating bushing, or so arranged that it would be impossible for the lead wire to come in contact with the case of the meter. When protected from the case by an insulated bushing the surface insulation is not only ample for the limiting line voltage of this class of apparatus, but also provides good ground insulation. Both sides of the line should be carried through the meter with both of the shunt leads taken off inside the meter, thus protecting it from persons desiring to tamper with its operation.

The current and voltage coils should be well insulated from the iron of the electro-magnet, so as not to break down under lightning discharge. These coils should be form wound, permitting cheap and ready repairs and minimizing stock of spare parts.

Dust is the chief enemy of an accurate meter, as will be demonstrated by a thorough cleansing of the bearings and moving parts of any meter that has been in operation for a considerable time. Many makes of meters have plenty of evidence of being dust-proof, but on close examination one may see that they are such in name only, and that the meter would have to be sealed in a glass case to be at all dust-proof.

The elements which vitiate the permanence of calibration of a meter in service are ageing of the permanent magnets, variation due to changing conditions of load, voltage, frequency, temperature, wave form, etc., and friction of whatever cause. The first of these elements is possible in isolated cases with any make of meter, but is practically absent in all makes of meters using permanent magnets whose magnetic circuit is one continuous piece of steel with a very narrow air gap. The second will be discussed under electrical characteristics. The third is due almost exclusively to the wear of the jewel bearing, and features should be incorporated into the design of the moving element and jewel bearing which will minimize the chances of a meter developing excessive friction.

The bearing after all is the strategic point of a service meter, and upon it and the elements affecting its life should be centered the best efforts of the designer. A construction which will make the friction a constant value permits the introduction of a compensating torque which will just overcome this constant friction.

The bearing should be so designed that the bearing point or pivot should not be continuously at one point, but be free to move at a speed which is different from that of the moving element, this different speed continuously presenting new bearing surfaces between the jewel and bearing point or pivot. This condition is best met by a bearing of the design shown in Fig. 1, which consists of a steel ball between two cupped sapphire jewels, one of which rotates

with the shaft, and the other is mounted stationary in the jewel screw. A bearing of this type not only decreases the initial friction but by reducing the relative speed of the bearing point (the steel ball) and the jewel the life of the meter is multiplied several times, and consequently the life accuracy of the meter is increased in the

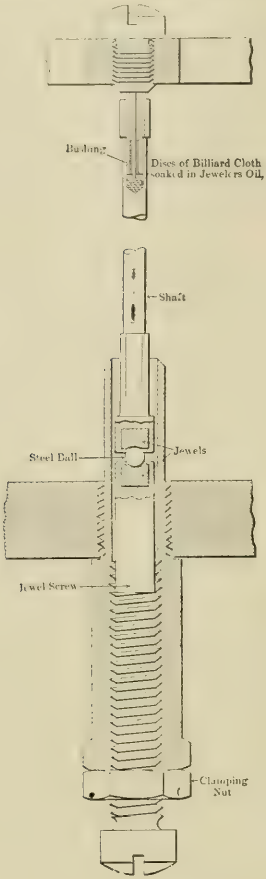


FIG. 1.

same proportion. A further increase of life is obtained by the ball rotating in an orbital path instead of on a single point. The wear on the jewel is distributed over considerable of its surface and thus reduced to a minimum. The ball being free to move in any direction wears uniformly over its entire surface and is always in good operating condition, and has scarcely any tendency whatever to increase the friction of the bearing. The top bearing shown in Fig. 1 has proven very effective in reducing friction and preventing noise.

The dial should be plain and easily read, having no unnecessary markings upon its face. To minimize mistakes

FIG. 2.

in reading the value of one division of the lowest reading counter should not be less than one kilowatt for any capacity of meter.

ELECTRICAL CHARACTERISTICS.

A thorough test should be made of the load and voltage curve of the meter, and where possible, a frequency curve should be taken. All three of these curves must be known to predict with any accuracy the performance of the meter under any other conditions of voltage and frequency than normal.

A type of meter should not be accepted which will not give a load curve of an initial accuracy of plus or minus 2 p. c. from 2 p. c. of full load to 50 p. c. overload, and maintain this accuracy in service for a considerable period when operated under normal conditions. Neither should a meter be approved which will not be accurate within plus or minus 2 p. c. from 50 p. c. of normal voltage to 25 p. c. overvoltage, and should have no tendency to creep under these conditions. Most makes of modern meters will have an error of less than 2 p. c. for a 10 p. c. change from normal frequency.

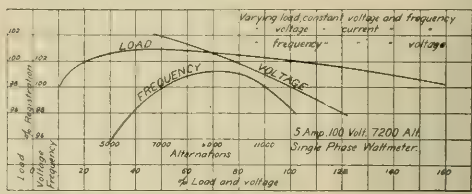


FIG. 3.

Characteristics of a meter with an unsatisfactory load and voltage curve.

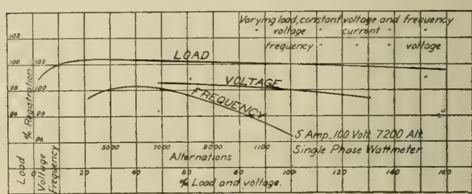


FIG. 4.

Characteristics of a meter with a satisfactory load, voltage and frequency.

The torque or driving force of the meter should be as large as it is possible to obtain with a minimum weight of moving element. To make the effect of friction as slight as possible the ratio of the torque necessary to overcome friction and the driving torque should be a maximum. This ratio may be increased by reducting initial friction and eliminating the causes tending to its constant increase; or it may be increased by an efficient design of the electro-magnet. Any attempt to increase this ratio by increasing the weight of the moving element above the minimum for mechanical strength is a gain only at the sacrifice of a considerable portion of the life of the meter.

The loss in the shunt and series coils should be small and the meter should be accurate on both inductive and non-inductive loads.

When it is desired to measure the energy of a circuit by a meter connected into the circuit through the medium of either or both series or shunt transformers, these transformers should be especially designed for use with meters.

Where there is to be a charge made according to the readings of such a meter the writer would recommend that this meter have its own individual series transformer.

CAPACITY.

When an installation is to be metered, a meter should be selected for the average load so as to utilize the inherent overload capacity of the integrating wattmeter. This is a feature usually taken into consideration for house service meters, and frequently neglected for switchboard service meters in the attempt to select a meter large enough to take care of the future growth of the station. The writer has in mind a modern switchboard installation in which the engineer insisted on such a large capacity meter that when several years later the attendants attempted to take hourly readings on the meter under full station load, they frequently got a smaller reading the last hour than the reading for the preceding hour. For switchboard service the meter should have a dial similar to that shown in Fig. 4, which will permit accurate hourly readings.

MAINTENANCE OF METERS.

Service meters have an inherent tendency to run slow after considerable use, and consequently should have a periodic inspection and test, the frequency of which will depend upon the types of meters used and the class of service.

This periodic test to be of any value can of course only be made while the meter is in service, and should be sufficiently accurate to indicate whether or not the meter should be continued in service or removed for recalibration. Several methods are used for this periodic test, such as an adjustable load of standard lamps and a voltmeter, or what is more convenient, and, when used with discretion, more accurate and reliable, a special standard integrating wattmeter. When using the latter method, it is only necessary to compare the speeds of the two meter discs to determine the accuracy of the meter under test. The special standard integrating wattmeter is usually provided with several current windings and at least two voltage windings so as to cover the range of the several capacities of service meters in use by the Central Station.

This meter should never be used as a primary standard, but as a secondary standard, and then only as such when the Central Station has a reliable and accurate standard for frequently checking its calibration

When the special standard integrating meter is of the same type as the meter under test, they will be subject to the same variations with changes of load, voltage, frequency, temperature, etc., and the relative speeds of the discs of the standard and the meter being tested will indicate directly the accuracy of the service meter. When, however, the standard and the service meter are of different types, the performance of both the standard and the type of service meter under varying load, voltage, frequency, temperature, etc., must be known, and allowance made for their difference before the standard meter will accurately indicate the condition of the meter being tested.

A reference to Fig. 3 will show how conditions may arise such that a meter will be in error several per cent. With an increase of 10 p.c. in frequency, at a 40 p.c. load and 90 p.c. voltage, the meter would be nearly 3 p.c. fast. If this meter was being tested by a standard integrating meter with characteristics same as shown in Fig. 4, it would be 3 p. c. fast. However, if tested by a standard meter with the same characteristics as shown in Fig. 3, it would indicate the same as the standard meter while it is actually 3 p. c. fast.

The primary standard is the "keystone" of the entire meter system. An operating company equipped with a good reliable and accurate standard and several of the integrating test meters can maintain cheaply and accurately a large number of service meters and increase its revenue by a considerable percentage.

The primary standard used in the calibration of other instruments should be of high accuracy in order to reduce the effect of any accumulative error. As they are not moved about to any great extent, they can be made of a size to obtain large controlling force. The type which depends upon the mutual attraction between two sets of coils is the form most suitable for a standard instrument, since in this form the minimum of disturbing influences enter. This type may be used on either direct or alternating current, is independent of frequency, wave form and power factor. A type of instrument of this kind which has recently been put on the market includes in its line a meter designed especially for testing integrating wattmeters, and it has a range equal to any three stand-

At 710 Hood St

Type	Make	Amperes	Volts	Constant		
B.	W.E. & Mfg Co.	5	100	—		
Watts	**Power Factor**	**Revolutions**	**Time**	**% Slow**	**% Fast**	**Index**
500		25	60.6	1		
20		1	62.4	4		191 KW.

Condition of Meter: Slow on light load

Tested by: J. R. Craig

Date of Test: 11-21 1904 Entered on Meter Card 11/24

Fig. 5.

ard meters obtainable for this class of service. This meter has a range of accurate readings from 10 to 10,000 watts at 100 volts, and proportionate range at other voltages.

No maintenance bureau is complete without a convenient system of recording both the line and laboratory tests of the service meter. The sample cards illustrated herewith are especially adapted for this use and are evolved from many years' effort on the part of the Central Station manager to obtain a comprehensive and convenient system of records.

The smaller card shown in Fig. 5 is used in the field for noting the condition of meters as examined when in service. From these reports the meter expert decides as to the advisablilty of continuing the different instruments in service or of having them replaced and brought in for re-adjustment.. These cards are made of the standard size for a 3 x 5 inch card index. For convenience in use, they are mounted on stubs and fastened together in books.

The larger card contains the record of changes in service and adjustment, and gives a complete history of the meters, including date of receipt, time of installation, length of service and electrical performance. It has space for six entries, which will cover a period of from three to six years, varying with the frequency with which changes

METER CARD

Meter No. 206258 Date Inv. 1-4-04 Make W.E. & Mfg Co. Type B

Mfr's. No. 206258 Amp. 5 Volts 100 Const. —

	Date	Address Cause	Index	Test: True Watts	Rev	Time	Per Cent Registration	Readjusted Within Per Cent
Installed	'04		KW.	500	25	59.8	100.3	
	1/8	710 Hood St.	0.	20	1	600	1000	
				500	25	60.0	1000	
Removed	11/24	Do.	194	20	1	61.5	97.5	Two
Installed				500	25	60.0	100.0	
	11/30	Do.	"	20	1	60.5	99.2	
Installed								
Removed								
Installed								
Removed								
Installed								
Removed								

Fig. 6.

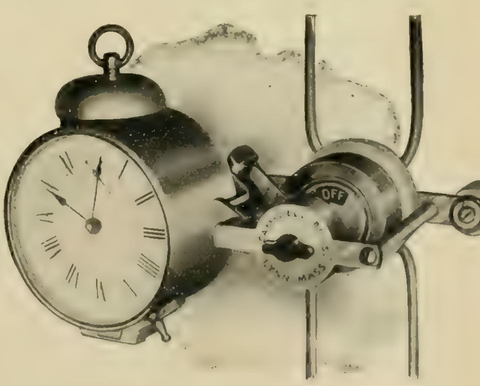
are made in adjustment and installation. The size is 4 x 6 inches, and each card is provided with a round hole for the retaining rod in a card index file.

There are many points in the design of service meters of prime importance (to the operating company) which have not been discussed, but an effort will be made to focus attention on the most important features, not a few of which, in the writer's opinion, are entirely overlooked in the selection and maintenance of service meters.

—WM. BRADSHAW.

THE CAMPBELL TIME SWITCH.

The Campbell Time Switch, as illustrated herewith, is a new departure in the line of shutting lights off and on automatically. It is neat in design and can be placed anywhere the wires happen to run; no shelf to build, no closet necessary, can be installed in five minutes, is artistically finished, well made and



The Campbell Time Switch.

reliable. The clock can be detached in a second, and repaired as quickly. These switches are made from 10 to 35 ampere, double pole or triple. Style "A" turns light on or off. Style "B" turns light on and off. The prices are very moderate. The Sayer Electric Company, of Montreal, are agents for the Dominion of Canada.

THE NEW PRESIDENT.

The president-elect of the Canadian Electrical Association, Mr. Aaron Abel Wright, M.P. for South Renfrew, was born at Athens, Leeds County, Ontario, June 6th, 1840. He is a son of Israel Wright, who also was born in Ontario. A. A. Wright was educated at Athens High School, Toronto Normal School, Montreal Normal School and at a private school in Quebec. He married Miss Jane Harvey, of Lachine, Que.

Mr. Wright is president and managing-director of The Renfrew Electric Company, Limited, of Renfrew, Ont., and has always taken an active interest in the Canadian Electrical Association. He was elected to the House of Commons at the general election in 1900

Mr. A. A. Wright,
President-Elect Canadian Electrical Association

and again at the general election in 1904. In politics he is a liberal. He has been a trustee of the Renfrew High and Public schools for 33 years.

COQUITLAM—THE LONGEST POWER TUNNEL IN THE WORLD.

"Gentlemen, I will let the waters speak for me". These were the words of Sir Henri Joly de Lotbiniere, Lieutenant Governor of British Columbia, as on June 10th he turned the golden key that opened the longest power tunnel in the world.

The steamer Britannia was charted by Manager Buntzen to carry the guests of the Vancouver Power Company and the British Columbia Electric Railway Company to the north arm of the Burrard Inlet. The power house was reached in exactly one hour and twenty-five minutes. Highfield orchestra had been retained for the occasion and enlivened the trip by music.

Arriving at the power house the party were taken in hand by Mr. Buntzen, Mr. Sperling and other officials of the company. Two of the three immense generators were in operation. Reaching the entrance of the tunnel, everything there was resplendent with flags and other symbols of rejoicing.

A platform had been erected over the short canal leading from the portal of the tunnel and on this a stand had been erected. The platform and the walk leading to it had been carpeted and the whole presented a very pretty effect. Here Sir Henri Joly, Mr. Buntzen, Premier McBride, Hon. F. Carter-Cotton, Mayor Buscombe and others took their places.

A golden key had been made for the occasion. On one side were the words "Presented by J. Buntzen, General Manager B.C. Electric Railway Company and Vancouver Power Company", and on the other side, "Opened June 10, 1905, by Sir Henri Gustave Joly de Lotbiniere, K.C.M.G., Lieutenant-Governor". An engraving of the power house also appeared on the key, as well as the length of the tunnel, 12,774 feet.

The opening ceremony began with a few words from Managing-Director Buntzen, who briefly announced that Sir Henri would turn the key, thereby starting a motor at the upper end of the tunnel, which, opening the gates, permits the water of Lake Coquitlan to flow into the Lake Beautiful or Trout Lake as it appears on the maps. His Honor, at exactly 1 p. m., placed the key in the marble slab on the little stand and gave it a turn, letting loose the sleeping waters of Lake Coquitlam and supplying almost unlimited power to the cities of Vancouver and New Westminster and surrounding districts. Just 35 minutes later the flood poured through, carrying on its bosom a gay float bearing greetings from Lake Coquitlam. This completed the ceremony and all adjourned to the large tent where the banquet was spread.

Elaborate preparations had been made, great taste was displayed in the decorations and garnishments of the festal board, and the two hundred guests found their allotted places at the three long tables without the slightest confusion. At the cross table at the head of the long table sat Mr. Frank S. Barnard, who acted as chairman. On his right sat His Honor, while to the left sat Premier McBride, Mayor Keary, of New Westminster, and Mayor Barnard of Victoria. To the right of His Honor sat Mr. Buntzen, Sir Charles Hibbert Tupper, Mayor Buscombe and others. The luncheon, like everything else in connection with the day's outing, was a credit to the company.

The toast list was opened by "The King", which was duly honored, all rising to their feet and joining in the National Anthem. The "Lieutenant-Governor" was proposed by Mr. Buntzen. In the course of his remarks he said that as King Edward was called the first gentleman of England so might Sir Henri be called the first gentleman of British Columbia. Replying, Sir Henri expressed his pleasure at being present and at the honor conferred upon him and said that the occasion would long be associated in his mind with the last function at which he had presided, the opening of New Westminster bridge. Such feats as these were a credit to the province and he felt proud to be connected with them. He felt proud to think that the work of the tunnel had been done by local engineers and contractors.

The toast to the Dominion and Provincial Parliaments was replied to by Sir Chas. Hibbert Tupper and Premier McBride. A toast to the cities of "New Westminster, Victoria and Vancouver," was then drunk. "The B. C. Electric Railway Company" was proposed by Mr. J. C. Brown, of New Westminster, who alluded to the tunnel as the biggest "bore" in Canada. Mr. Buntzen was called on. The popular manager arose amid loud cheers, the heartiest of which seemed to come from those of the company's employees present. He referred to the tendency towards municipal ownership of electric plants. In the earlier life of a city it was not possible to finance these enterprises as well as a private company. Private capital could venture further and risk more than could a municipality. Mr. Buntzen referred to the excellent relationship existing between his company and its employees. This was one thing he was very proud of. In conclusion he voiced his regret at leaving British Columbia for London, whither he goes to occupy the highest position in the gift of the

directors, that of managing-director. He paid high tribute to his successor, Mr. R. H. Sperling.

The "London Directors" were then toasted. Mr. Francis G. Hope, the lately appointed secretary-treasurer of the company, from London, brought the directors' greetings. He stated that the directors were thankful to Mr. Meredith and Messrs. Herman & Burwell, the engineers for the work, but above all were they grateful to the fertile brain of Mr. Buntzen for his managment of the undertaking.

Hon. Mr. Carter-Cotton proposed the health of "The Men who Built the Tunnel," quoting from Milton. He said that "Peace hath her victories not less renowned than war," and he felt that the enterprise just completed would rank amongst the greatest of undertakings, and all honor was due to the men who engineered it through. Replying, Mr. Wynne Meredith spoke of the assistance rendered by both chief and men, and he was well satisfied to have but a part in the work. Mr. Herman and Mr. Reaume also replied.

The guests returned to Vancouver about 8 p.m. All present spoke in flattering terms of manager Buntzen and the officials of the companies.

THE TRAY PLATE STORAGE BATTERY.

Mr. P. B. Warwick, of the Tray Plate Storage Battery Company, of Binghampton, N.Y., is installing a Tray Storage Battery in the sub-station of the Shawinigan Water & Power Company at Montreal. This battery is unique and has a number of very desirable features. The elements are made in the form of pans or trays, the underside of each tray being the negative and the upper or inside being the positive. These trays are nested one in the other like a pile of tea saucers and are insulated one from the other by porcelain discs. The piles are surrounded and completely enclosed in heavy corrugated glass to prevent all chance of dust and foreign matter entering the trays.

The electrolyte is poured into the top tray and overflows into the next lower tray and so on until each tray is full, when the overflow is conducted into a lead-lined drip box. When the battery is being charged the electrolyte swells and overflows from pan to pan and finally into the drip box, whence it is transferred to the top pan again; in this way the electrolyte is maintaining an even density in every tray and the necessity of testing the specific gravity of each cell is obviated.

The small floor space is also another commendable feature, a tray having a capacity of 100 ampere hours requiring only a floor space of about 24 x 26 inches. The active material is held in close contact with the conducting support by a most peculiar method of spinning the lead on both sides of the plate at once, and consists of chemically pure electrolytic lead sponge or felt, compacted by being rolled under very heavy pressure. The method of preparing the lead sponge is a trade secret and is most zealously guarded by the Tray Plate Battery Company.

It is quite different to the regular method of pasting on a mixture of red lead and acid and water. By the peculiar construction of the elements the washing and wasting action is done away with and the trays slowly increase in capacity instead of decreasing, the reason for this being that the positive electrode being in the form of a pan or tray, the active material, even if as soft as mud, is in intimate connection at all times.

With the exception of the two terminals there are absolutely no connections or jumpers, one side of tray being the negative of one cell and the other side of same plate being the positive of the next cell or tray above. This method very materially reduces the resistance of the battery and allows of an extremely heavy discharge without injury to the battery.

The Tray Plate Battery Company have batteries in various parts of the United States and also in foreign countries that have been in use for upwards of three years, and all show an increased capacity. A few plants are here given: Broome County Buildings, Binghampton, N.Y.; Waterworks, Binghampton, N.Y.; Central Iron & Steel Works, Harrisburg, Pa.; Telephone Exchange, Greenville, Alabama; Hotel German, New Tripoli, Pa.; Walters Sanitarium, Walters Park, Pa.; Walters Sanitarium duplicate plant; Textile Machine Works, Wyomissing, Pa., three orders, and many others having over 10,000 cells in use.

The Company have also made a small storage battery for automobile ignition of a very novel and pleasing style. The cells only measure 4½ x 2½ x 7 inches and are made of translucent celluloid and are absolutely sealed with the same material. They have all the advantages of glass jars but are practically unbreakable. During the season of 1904, a Pope Toledo 4-cylinder 59 h.p. car averaged 2,650 miles on one charge with a set of this make of cell.

THE CANADIAN WHITE COMPANY.

The Canadian White Company, Limited, has been incorporated in Canada to carry on a general contractingand engineering business, on similar lines to J.G. White & Company, incorporated, of New York; J. G. White & Company, Limited, London, England.

The letters patent of the Canadian company were granted the latter part of May and the organization of the compay is now being completed.

The Canadian White Company, Limited, will carry on a general contracting and engineering business and will undertake any civil, mechanical, electrical, hydraulic and building work. It will be fully equipped to handle large construction contracts for steam or electric railways, and will be prepared to design, build, equip and operate electric lighting plants and power installations, gas works, water supply, sewerage systems, piers, docks, harbor works, office buildings, apartment houses, hotels, etc.

The contracting and engineering departments of J. G. White & Company, incorporated, of New York, will at all times be at the service of the Canadian Company and the company will further have the benefit of the experience of J. G. White & Company, Limited, London, England, and the Waring-White Building Company, London, England. This insures the Canadian Company from its inception, the benefits and advantages to be derived from a very long and successful experience in the contracting and engineering business.

The Canadian White Company, Limited, will have upon its Board as stockholders, strong representative business men well-known throughout Canada, and will be organized to carry on its business in the most thorough and expeditious manner.

The general manager of the Company will be a prominent civil engineer with large experience in railway construction, etc., and who has held executive positions.

Mr. H. P. Douglas, formerly vice-president and general manager of the Canadian Otis Elevator Company, Limited, will be treasurer of the Company.

The contracting and engineering staff will be sufficient at all times to carry out promptly and efficiently all works undertaken by the Company. The men for this department will be competent engineers who have had long and thorough experience.

Mr. H. C. Hitch has been engaged as superintendent of building construction. Mr. Hitch has been for several years connected with the Thompson-Starrett Company, of New York, as superintendent. Recently he has had full charge of the erection for the Thompson-Starrett Company of the Union Bank Building at Winnipeg.

The organization as outlined above, with its allied interests, insures prompt and efficient attention to any contracting or engineering matter that may be brought to its attention.

The Canadian White Company, Limited, intends making a feature of building construction, and is now prepared to contract for the better class of building work, such as office buildings, apartment houses, hotels, industrial plants, warehouses, etc.

The Company invites correspondence on all contracting, engineering and building propositions and will be glad at all times to investigate and report upon any business that may be brought to its attention.

IS THE TURBINE BUSINESS GROWING?

That the steam turbine is rapidly increasing its foothold in the power field is evidenced by the remarkable increase in manufacture of the well-known Westinghouse-Parsons type. During the six months ending June 30th, 1905, the Westinghouse Machine Company, exclusive builders of the Westinghouse-Parsons type, have contracted for no less than 82,000 kilowatts in turbo-generating machinery, averaging nearly 1,175 kw. capacity per turbine unit. These machines range in size from 200 kw. to 7,500 kw. The latter will be the largest turbines in the world, and three units of this size are under contract for Greater New York railway and lighting power stations. In the distribution of these among the various industries, the electric railway has claimed the largest number of machines, averaging 1,496 kw. in capacity; next in order, industrial plants, averaging 571 kw. capacity, and light and power plants, averaging 1,529 kw. capacity. In the order of total capacity, railway plants have required 38,900 kw., lighting plants, 26,300, industrial 12,000, miscellaneous 4,800.

This list bears excellent witness to the increasing possibilities of the turbine, and presages a brilliant future. The equipments noted represent solely actual sales only, and not including contemplated business or partially closed contracts.

The new building to be erected by the Bell Telephone Company in Brantford, Ont, will be located on Dalhousie street and will cost about $40,000. A central energy switchboard will be installed.

The British Columbia Telephone Company are extending their system from Vancouver across Burrard Inlet to North Vancouver where a small exchange will be put in operation. The Company have secured 40 subscribers already in the municipality.

AN ATTRACTIVE DISPLAY.

The Sayer Electric Company, Beaver Hall Hill, Montreal, had an attractive electrical display as a welcome to the Canadian Electrical Association, which convened in that city last month. Besides the electric lettering, the front of their store was beautifully

DISPLAY OF THE SAYER ELECTRIC CO., MONTREAL.

decorated with flags and bunting. Notwithstanding that Montreal is designated an "electric city," the Sayer Company was the only firm to electric light their premises in honor of the convention.

C.G.E. APPARATUS.

The Canadian General Electric Company's exhibit at the Canadian Electrical Association Convention in Montreal last month was representative of the large line of electrical apparatus and supplies which they manufacture. The display was attractively arranged and was the subject of much favorable comment. Their headquarters were in the Windsor Hotel.

The Canada Foundry Company, Toronto, have just issued Bulletin No. 29 relating to single and duplex steam pumps. It gives a great deal of information about the operation of these pumps for the handling of fluids against ordinary pressure and for general purposes.

The Robb Engineering Company has received from Ahearn & Soper, Limited, Ottawa, an order for a 50 horse power engine for the Dunlop Tire Company, Toronto.

The Golden Electric Light Company, Golden, B.C., have placed an order with the Robb Engineering Company for an 80 horse power engine and boiler.

THE BABCOCK & WILCOX BOILER.

As an evidence of the growing favor with which the well-known Babcock & Wilcox boiler is being regarded in the Dominion of Canada, we may state that the following are among the many recent orders received: Canadian Pacific Railway Company, Montreal shops, 1,400 h.p. additional, equipped with Babcock patent superheaters and automatic chain grate stokers; Winnipeg City Water and Electric Light Plant, 500 h.p., equipped with Babcock patent superheaters and automatic chain grate stokers; Winnipeg Electric Railway Company, 2,000 h.p., equipped with "Neemes" patent shaking grates, etc.; Dominion Coal Company, Limited, 2,500 h.p.; J. R. Booth, Ottawa, 2,000 h.p., boilers and superheaters; Belgo-Canadian Pulp & Paper Company, 500 h.p.; Central Electric Company, Montreal, 200 h.p. additional; C.P.R., Winnipeg Hotel and Station, 800 h.p.; C.P.R. shops, Winnipeg, 1,500 h.p., with superheaters; Canada Car Company, Limited, Montreal, 1,800 h.p., with superheaters; Calgary City Electric Lighting Plant, 500 h.p., with "Neemes" shaking grates; F. W. Bird & Son, Hamilton, 75 h.p.; South Western Traction Company, London, Ont., 900 h.p.; Singer Manufacturing Company, St. Johns, Que., 1,625 h.p. We might also mention that the Dominion Government last fall installed Babcock & Wilcox marine boilers in the Dominion icebreaker "Montcalm," which was used so successfully in breaking the ice on the St. Lawrence during the past winter. The Babcock & Wilcox Company are also installing an additional economizer and induced draft plant for the Canadian Pacific Railway at Fort William.

The annual meeting of the Electrical Trades Association of the United States and Canada took place in Montreal on June 23rd.

The annual picnic of the employees of the Montreal Street Railway Company will be held at Riverside Park from August 14th to 20th inclusive.

The Provincial Telephone Company, Limited, has been incorporated by the New Brunswick Government to construct and maintain telephone lines throughout the county of Victoria. The capital stock is $9,000, and the promoters include Mr. Donald Fraser, of Fredericton, and Mr. Alexander Straton, of Andover.

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ELECTRICAL NEWS

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Transmission Plant of the Mexican Light and Power Company*

By Francis O. Blackwell.

The plant of the Mexican Light & Power Company at Necaxa, Mexico, will be one of the largest power plants in the world and, in addition, will deliver power over a greater distance (171 miles) than has yet been undertaken by any other installation. The Tenango and Necaxa rivers drain a portion of the central plateau on which the City of Mexico is situated, and at a point about 100 miles northeast of the City, pass through the mountains at an elevation of 4,300 feet above sea level. A few miles below the town of Necaxa the Tenango river flows into the Necaxa river and eventually discharges into the Gulf of Mexico about sixty miles farther east.

There exists on both rivers a remarkable series of waterfalls with a total drop of about 3,000 feet in 3 miles. The rivers have a combined drainage area of 227 square miles upon which the rainfall varies from 85 to 135 inches per year, most of it being concentrated in the rainy season from May to December. The combined flow of the streams is, as might be expected, extremely variable, the minimum recorded flow being one cubic metre a second and the maximum 90 cubic metres. The average flow during the year of lowest recorded rainfalls was about 7 cubic metres per second.

MEXICAN LIGHT AND POWER COMPANY—ONE OF THE 8200 H. P. WATER WHEELS BUILT BY ESCHER, WYSS & COMPANY, ZURICH, SWITZERLAND.

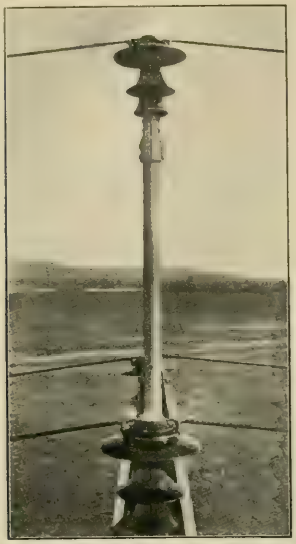
The plan of development decided upon was to turn the Tenango river into the Necaxa by means of a diverting dam, 16½ feet high and 280 feet long, and a tunnel 11 x 7 feet in cross section and 3,000 feet long. A favorable location for a large storage reservoir exists at Necaxa, making it possible to equalize the entire flow of the streams during a dry year. A short distance below the site for the reservoir there are two falls in the Necaxa river, one 300 and the other 730 feet in height, which, together with the rapids above and between them, give a total fall of 1,300 feet in a mile. The initial plant will utilize this head, but there is a further fall immediately below of 1,300 feet which will be developed as soon as the first plant is completed. The two plants will eventually be capable of furnishing 80,000 electric horse-power.

The ground at the site of the dam is an unreliable volcanic rock, and, as no rigid bottom exists upon which to build masonry, an earth dam has been decided upon. This dam will be 177 feet high and 600 feet long at the crest, with a width at the base of 950 feet, and at the top of 54 feet. The slopes will be 3 in 1 on the up stream and 2 in 1 on the down stream faces. About 2,000,000 cubic yards of material will be required in its construction, and will be obtained from the neighboring hills and sluiced into place by the methods that have been so successfully used in many hydraulic fill dams in the western part of the United States under similar conditions.

The hydraulic system originated in the placer mines in California and is the most rapid and economical method of excavating and transporting large quantities of earth and rock wherever a sufficient volume and head of water are available, as at Necaxa. The method employed is to first loosen the earth by blasts and then wash the material into flumes which carry it to the site of the dam. A low embankment is first made at the upper and lower sides of the fill and drain-

* Extracted, by permission, from "Electric Power Developments in Mexico" in Cassier's Magazine.

age culverts are provided to the centre. The flumes discharge their contents near these embankments, the coarse stone and gravel settling there, while the finer materials are deposited near the centre, forming an impervious core wall. As an additional protection, the inner and outer slopes of the dam are protected by a layer of broken stone from 8 to 60 feet thick. The spillway is cut out of the hills to the north and discharges the overflow well down stream where it cannot endanger the work.



Mexican Light and Power Company View of Insulators made by R. Thomas & Sons Company, East Liverpool, Ohio.

The reservoir formed by this dam, when full, will cover an area of three square miles and have a storage capacity of 1,580,000,000 cubic feet. The outlet from the reservoir will be through a tunnel 1550 feet long, driven in the rock to the south of the dam. Water is admitted through screens to two vertical pipes embedded in concrete, each pipe having gates at four different levels, so that the gates will not have to be operated under pressure.

The vertical pipes are joined to horizontal penstocks, 8 feet in diameter and ⅜ inch thick, which pass through the tunnel, the latter being subsequently filled with masonry. The penstocks, after they leave the tunnel, are reduced to a diameter of 7 feet and are carried down stream a distance of 2800 feet, 900 feet of which are through tunnels. At this point, under a head of 180 feet, the penstocks are joined to a receiver, 22 feet long and 7 feet in diameter, from which six smaller pipes conduct the water to the power house. All pipes are connected to the receiver through gate valves, and, in addition, a valve in the center of the receiver permits the two halves of the system to be separated from each other, so that either half can be shut down without interfering with the other.

The pipes from the receiver are carried down to the power house, a distance of 2300 feet, 1900 feet of which are through two parallel tunnels constructed at an angle of 41 degrees from the horizontal. There are three pipes in each tunnel supported on concrete with anchorages and expansion joints. These pipes are seamless steel tubes with flanges, each piece being forged complete from one piece of sheet steel. Before the flanges are hammered out, two cast steel clamping rings are slipped on each 30 foot section of pipe. The outside diameter of the tubes is 30⅝ inches throughout the entire length of the line. The internal diameter of the tubes is less at the lower end than at the upper on account of the pipe's greater thickness, which varies from 0.4 to 0.95 of an inch, the minimum diameter being 29 inches.

The static head at the lower end of the 30 inch pipe, with the reservoir full, is 1430 feet, which is reduced to 1300 feet when the reservoir is empty and the friction loss is allowed for. A vertical relief pipe, 240 feet high and 20 inches in diameter, is connected to the upper end of each penstock. Each section of tube before being shipped from the works of the manufacturer in Germany, was subjected to a hydrostatic test of twice the maximum pressure to which it will be subjected in service. This pipe is stronger and more reliable than one built up of plates and flanges riveted together, such as is commonly used, and the smooth interior will materially reduce the loss of head due to friction.

The power house is located in the Necaxa canyon a short distance below the 750 foot waterfall. It will have a rated output of 30,000 k. w. or 40,000 h. p., and a maximum capacity of 50,000 h.p. There will be six main water wheel units, each capable of delivering 8200 h.p. They are of the impulse type built by Escher, Wyss & Company, of Zurich, Switzerland, and are of 100 inches pitch diameter, running at 300 revolutions per minute. Each has two 4½ inch square regulating nozzles fixed on opposite sides of the wheel, but joined together so that they are opened and closed simultaneously.

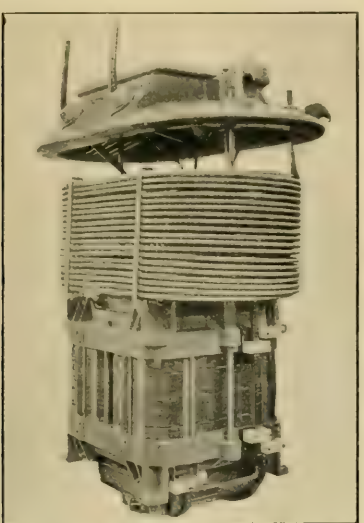
A by-pass valve is provided at the end of the pipe

Mexican Light and Power Company—One of the Line Towers.

line which feeds each unit and is mechanically connected to the nozzles, so that when one opens the other closes, keeping the flow of water in the pipe constant. This is necessary to avoid rams which might prove disastrous with such a high head and long penstock.

A vertical shaft, 14 inches in diameter, carries both the field of the generator and the water wheel. The weight is supported by a thrust bearing, 30 inches in diameter, under which oil is forced at a pressure of 150 pounds per square inch by a pump driven by the main water wheel. This construction has many marked advantages over impulse water wheels heretofore built with a horizontal shaft and a single deflecting

nozzle. The double nozzle reduces the size of both the jet and the bucket, and permits the use of a smaller diameter of water wheel and a higher speed of rotation without sacrifice of efficiency. The nozzle and by-pass are much more easily operated and possess the other good features of a deflecting nozzle. As the nozzles



MEXICAN LIGHT AND POWER COMPANY—ONE OF THE 60,000 VOLT TRANSFORMERS, BUILT BY GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

are set in opposition to each other there is no thrust on the steady bearings, and no weight is carried by the latter, so that they need be only a fraction of the size required for a horizontal shaft. The diameter and length of the shaft itself can also be much reduced. The oil thrust bearing is a very simple and reliable device which operates with a minimum of attention.

The amount of water supplied to each wheel and the maximum power can be adjusted at the governor so that water will not be wasted unnecessarily, and the by-pass is also arranged so that, if desired, it can be adjusted to close slowly after opening—a feature which may be desirable with fairly steady loads.

Each unit is equipped with a 28-inch diameter gate valve and a governor of the Escher-Wyss type, both operated by hydraulic power. The six 5,000-KW. alternators direct connected to the water wheels, running at 300 revolutions per minute, were furnished by the Siemens-Schuckert Werke, of Berlin. They are of the revolving field type and generate three-phase current at a periodicity of 50 cycles, and a potential of 4,000 volts. Two of the alternators are equipped with 60-KW., direct-connected, 125-volt exciters, but in ordinary operation exciting current will be obtained from two 250-KW., 125-volt generators driven by induction motors wound for 4,000 volts. Motor-generator sets are employed, because with small wheels the small nozzles are constantly stopped up by materials floating in the water.

The low-potential current from the generators is raised to high potential by five banks of oil transformers, each bank consisting of three 2,000-KW. units which can deliver power at 40,000, 50,000 or 60,000 volts to the transmission circuits. The transformers are each placed in a closed fireproof compartment, with steel bulkheads separating them from the generator room, on account of the large quantity of oil used to insulate them. The heat generated, due to the losses in the iron and copper, is carried away by copper cooling coils in the transformer cases, through which water is constantly circulated by motor-driven pumps.

The wiring consists either of cables in conduits or of bare wires in brick and concrete compartments, so that the damage from an arc is limited and cannot injure adjacent circuits. This is particularly important in laying out the 60,000-volt circuits, a substantial wall isolating every wire, switch or lightning arrester. The main switches are all of the oil type controlled electrically from a distance, and any switch will open instantaneously a short circuit of the entire power system. They are also equipped with disconnecting air switches so that they can be cut off from the system for repair and inspection. The high-tension wiring and the lightning arresters are all in a room by themselves behind the transformer pockets.

The oil switches are on the gallery above, with the controlling switchboard in the centre, where the operator can obtain an unobstructed view of the machinery in all parts of the building. The small controlling switches for the large oil switches are, with the miniature lamps which indicate their position, mounted on a benchboard with dummy bus-bars to form a wiring diagram so that the attendant can always see how the apparatus is connected and thus avoid mistakes.

On vertical panels above the bench-board are the indicating instruments which show at any instant the speed, potential and power at which the plant is operating. These instruments are also so placed with relation to the dummy busses and operating switches that the operator cannot become confused. At the back of the board are the registering instruments which make a record of the pressure and output of the plant.

MEXICAN LIGHT AND POWER COMPANY SWITCHBOARD IN POWER HOUSE, FURNISHED BY GENERAL ELECTRIC COMPANY.

The switchboard forms a room, with the instruments and controlling devices on the outside, and the doors at the ends to give access to the inside. The transformers and switchboard for the power house and substations were furnished by the General Electric Company, of Schenectady, N.Y.

The power house is a substantial steel and masonry building, with concrete and cement roofs, floors and

partitions, in which no combustible material of any kind is employed. All the machinery is placed where it can be readily handled by a 50-ton travelling crane. At one end are storerooms for supply and repair parts, and a machine shop equipped with all tools necessary to maintain the apparatus. The building is 235 feet long, 88 feet wide and 60 feet high.

The Necaxa plant is located in one of the most inaccessible parts of the State of Puebla, and for its construction it was necessary to build 30 miles of railroad, besides many miles of roads and trails. The material and machinery for the power house had to be lowered down cliffs and steep inclines by cableways for a vertical distance of 1500 feet, and nearly all the apparatus had to be transported over 4000 miles from Europe and the United States. A temporary plant, consisting of two Pelton water wheels driving air compressors and a 500-volt continuous current generator for operating the hoisting, pumping and other construction machinery, and lighting the work at night, was installed beneath the first fall at Necaxa.

There are four electric power transmission circuits and two tower lines from the power house to the City of Mexico, and two circuits from the City of Mexico to El Oro. They are carried by steel towers, on each of which are two circuits of 168,000-circular mils copper cable, equivalent to No. 000 B. & S. wire, supported on 14-inch diameter porcelain insulators. The towers for the transmission line are built up of steel angles with all parts heavily galvanized and with 3-inch x 3¼-inch corner posts spaced 16 feet apart across the line and 12 feet along the line. They are 50 feet high over all, the feet being set 5 feet in the ground. The six cables are supported 40 and 46 feet above the ground, the conductors forming two equilateral triangles with 6-foot sides. The towers will stand a horizontal side strain of 1650 pounds at each insulator pin, or 10,000 pounds altogether. The standard distance between them is 500 feet, but spans up to 1200 feet are made by allowing additional sag and employing special structures.

The insulators are made in three parts cemented together on the ground in Mexico. Each part is tested before shipment by subjecting them while wet to a test potential of 60,000 volts. After being assembled they are tested with a potential of 120,000 volts. The insulator pins are 15 inches long and made of 2-inch steel pipe set in drop-forged sockets, which in turn are mounted on a 4-inch pipe cross-arm for the lower conductors, and a 3-inch pipe extension for the upper. They are set into the insulators with Portland cement.

The conductors are six-strand copper cables, ½-inch in diameter, with hemp centers, and have a strength of 60,000 pounds and an elastic limit of 40,000 pounds per square inch. The cable is shipped in lengths of 3,000 feet, and joints are made with an 18-inch twisted copper sleeve. The stress on the cables and supporting structures is figured by assuming a wind velocity of 100 miles an hour and allowing a stress in the materials of one-half the elastic limit. The cables are attached to the insulators by clamps, no tie wires being employed. Telephone circuits of No. 10 copper wire are erected on each of the tower lines and are placed 10 feet below the high-potential cables.

The distance from Necaxa to Mexico is 96 miles, and from Mexico to El Oro 75 miles. The total length will therefore be 171 miles, making it the longest commercial power transmission yet constructed. There will be 1602 miles of cable and 534 miles of circuit in the high-potential system. The loss in the transmission circuits between Necaxa and Mexico will be 8 per cent. at full load, with 100 per cent. power-factor at 60,000 volts, so that the entire power can be delivered over two of the four circuits, or one-half the transmission system, with only 16 per cent. loss, should the other half be disabled. The loss in transmission from Mexico to El Oro is but 5 per cent.

The circuit breakers at Necaxa, Mexico and El Oro are arranged to automatically cut out any transmission circuit which becomes damaged without any interruption in the service. The sub-station buildings in the cities of Mexico and El Oro follow in general the design adopted for the power house. In Mexico there are twelve 1,800 kw. oil transformers in separate fire-proof compartments covered by a travelling crane. The switches and wiring are in separate cells and every precaution has been taken to isolate all parts from each other. In addition to the high-tension apparatus, an extensive low-potential feeder system for the city distribution is provided for in the switch-board. The step-down transformers are arranged to furnish current at either 1,500, 3,000 or 6,000 volts, as may be required.

The building is 203 feet long and 65 feet wide, and is located adjacent to the company's steam station, originally built by the Siemens-Halske Company. This steam plant now supplies the public lighting of the city and much private lighting and power. In it are installed six 1200-H. P., triple-expansion, condensing engines, running at 120 revolutions per minute, direct connected to 60 cycle, 1500-volt, three-phase alternators. Four 1000-H. P. Curtis steam turbines running at 1500 revolutions per minute are now being erected in advance of the completion of the water power installation to take care of the rapidly increasing business. Later, this station will be kept as a reserve, although it now seems probable that steam will be required even after the water-power plant is in operation, as practically all the power from the first Necexa development has already been sold.

At El Oro, a sub-station 115 feet long and 59 feet wide has been erected. This is similar to the one in Mexico, and the seven 1800-kw step-down transformers installed there are duplicates of those in the latter city.

The distribution to the gold mines of the El Oro and Tlalpujuhua districts will be 3000 and 6000 volts. The mines at Tlalpujuhua were first worked three hundred years ago by the Spaniards, who are credited by tradition with having taken enormous quantities of silver from them. That gold existed in the neighboring town of El Oro was known for a century, but it was not until comparatively recently that the cyanide process made it possible to recover the metal from the ores. The great success of the El Oro Mining & Railway, the Esperanza and the Dos Estrellas Companies, has brought the camp into prominence, and many other properties are now being actively developed. Enormous bodies of ore, the veins in places being 200 feet thick, have already been opened up over a wide extent of territory, and El Oro promises to rival, if it does not surpass, the Rand in South Africa, as the world's greatest producer of gold. The mines must, however, be worked on a large scale to be profitable, and the in-

troduction of cheap power has greatly stimulated the activities of the whole region.

The Necaxa plant has been designed with ample reserve power so that the failure of no single piece of apparatus or combination of accidents ever will be likely to cripple the plant. The pipe lines will be in duplicate, reserve units of each kind of hydraulic and electric machinery will be installed, and the transmission lines will have double and quadruple circuits. The buildings, transmission towers and other structures are of permanent and reliable character.

Mexico is generally admitted to be the best lighted city on the American Continent, and it is expected that the same high standard of service will be maintained after water power has replaced steam.

TWO IMPORTANT APPOINTMENTS.

Mr. A. B. Smith, of Toronto, has been appointed manager of telegraphs of the Grand Trunk Pacific Railway, stepping up from the position of superintendent of construction and maintenance of the G.N.W. Telegraph Company. The responsible appointment has fallen to one of the best known telegraphers in Canada. He has been in the service from office boy to superintendent, is a skilled operator, and has few equals as an electrician and line builder. Mr. Smith is a Canadian of Scottish extraction, and has the energy and physical capacity to back up his mental talents in the great work he is about to undertake. He will enter his new duties about November 1.

Mr. Thomas Rodger, formerly manager of the Great North-Western Telegraph Company, Montreal,

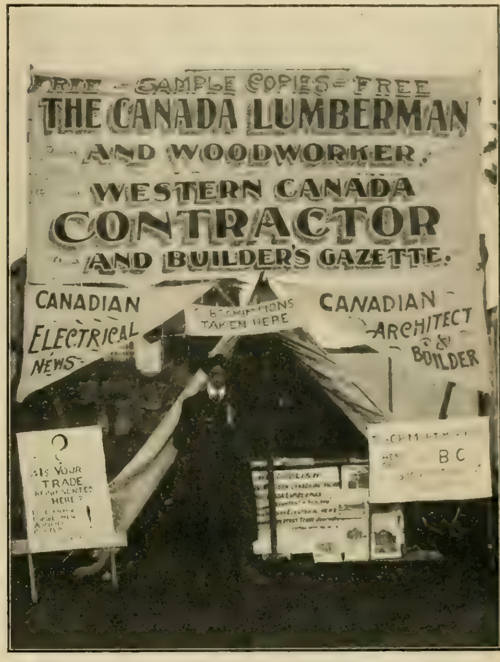
Mr. A. B. Smith.

has been appointed inspector of telegraph and telephones of the Grand Trunk Railway system east of the St. Clair River, with headquarters at Montreal. Mr. Rodger is one of the best known telegraph men in Canada, and in making the appointment the Grand Trunk officials consider they have the right man for the position. Mr. Rodger was connected with the Montreal and Great North-Western Telegraph Companies for thirty years, having risen from "check" to the position of chief operator.

Miniature roof protections for pole line insulators have become a necessity upon the high-potential transmission lines in California. The natural deposition of moisture upon them in fogs, or of dust in dry weather, is apt to cause escape of the current and eventual short-circuits resulting in burning and often destroying the pole. This is now provided against by sheltering all insulators by V-shaped boxes or sheds.

THE DOMINION EXHIBITION, NEW WESTMINSTER.

The recent Dominion Exhibition at New Westminster, B. C., was singularly successful. Notwithstanding the prevalence of rainy weather for the greater part of the time, the attendance was large and much interest was shown in the numerous exhibits. Mr. George A. Gall, the British Columbia representative of this journal, was



Our Headquarters at the Dominion Exhibition, New Westminster, B. C., September 27 to October 7, 1905.

permanently established on the grounds, his headquarters being shown in the accompanying engraving. Here he received hundreds of visitors from the West and some from the East. The publishers have unbounded faith in the future of Western Canada and intend in every possible way to promote the interests of western advertisers and subscribers. Our British Columbia office is located at Suite 3, 536 Hastings street, Vancouver, where friends of the paper will always be welcome.

ELECTRIC LIGHTING IN VANCOUVER.

Tenders were recently invited by the City of Vancouver, B.C., for electric lighting. For an enclosed series alternating system the price of the British Columbia Electric Railway Company, $40 per annum per lamp, was the lowest. On the basis of 500 lamps it represented an expenditure in ten years of $200,000. The Stave Lake Power Company offered to supply power at $22 per kilowatt per annum, the city to install its own distributing plant. The City Engineer reported that the cost for a 500 lamp installation, including transformer station and all necessary equipment, would be about $85,000. He figures that the annual charges would be $18,734.45, or for ten years an expenditure of $187,334.50, this being a saving in favor of the city plant of $12,656.

Later the British Columbia Electric Railway Company amended their offer and agreed to supply arc lights for $38 per lamp per year on a ten year contract, and it is probable that a contract will be entered into on this basis.

HEAT AND EVAPORATION COMPUTER.

Mr. James Milne, chief engineer and manager of the Underfeed Stoker Company, Toronto, has designed an ingenious and useful heat and evaporation calculator, by the use of which the necessity of referring to steam tables in books is removed. The following explanation of the computer may be of interest:

This rule is marked so as to agree with Peabody's tables and the latent heat of steam at atmospheric pressure is taken at 966 units.

Its action is based on the formula W $\left(\frac{H-h}{966}\right)$

where W = Actual evaporation in lbs.

H = Total heat units in steam.

h = Temp. of feed deg. Fah.—32 = (t—32)

Heat units in feed.

In working the rule the first thing to determine is H for a given boiler pressure. By placing the feed temperature on the lower slide so as to coincide with the boiler pressure and taking the reading on the lower scale of heat units as opposite 32 on the feed temperature slide we have H—(t—32) = (H—h). This gives the number of heat units supplied to every pound of water at a given feed temperature in order to convert same into steam at the observed boiler pressure.

The next process is to divide by 966, which is done in the designing of the rule, and all that remains is to multiply the actual evaporation by the factor of evaporation, which is readily done by taking the reading on the top scale agreeing with the actual evaporation on the upper slide.

The following rules and examples will illustrate the working of the rule:—

Rule 1.—To determine the heat units in steam at a given gauge pressure. Have the lower slide so that top or arrow points to the requisite steam pressure, the lower end of arrow points to heat units in the steam above 32 deg.

Example 1. What is the number of heat units in steam at 115 lbs. gauge pressure? Answer—1187.

Rule 2.—To determine the number of heat units applied to 1 lb. of water at a given steam pressure and feed temperature so at to convert same into steam. Set lower slide so that feed temperature agrees with steam pressure and opposite 32 at left hand of lower slide find number of heat units required.

Example 2.—Find number of heat units required to convert water at 127 deg. Fah. into steam at a gauge pressure of 125 lbs. Set 127 on lower slide so to agree with 125 lbs. gauge pressure and opposite 32 on slide find 1094 heat units.

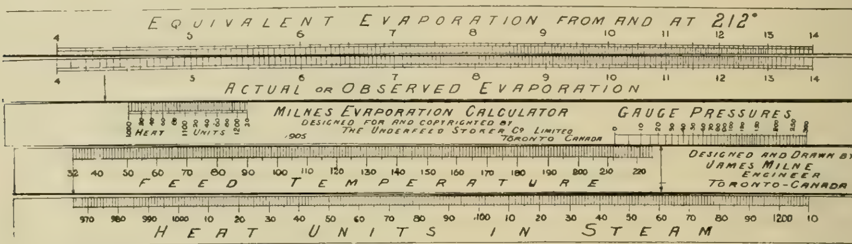
Rule 3.—To find factor of evaporation. Set the lower slide so that the feed temperature agrees with the boiler pressure. Note the number on the lower scale of heat units corresponding to 32 deg. on lower slide. Set upper slide so that the arrow points to same number of heat units in middle division of rule. Above 10 on top slide find the factor of evaporation. Move decimal point to the left.

Example 3.—Feed temperature 127 deg. Fah. Boiler pressure 125 lbs. Find factor of evaporation correct to 3 decimal places. Set 127 on lower slide so as to agree with 125 lbs. gauge pressure and opposite 32 on slide find 1094 and above 10 find 35. Move decimal point one place to left, 1.135 factor of evaporation.

Rule 4.—To find equivalent evaporation from and at 212. Multiply actual evaporation by factor of evaporation, or move lower slide so that temperature corresponds to boiler pressure. Note number opposite 32 deg. on lower scale. Set upper scale so that arrow points to same number of heat units in middle division of rule. Above the observed or actual evaporation on top slide find the equivalent evaporation.

Take example 3 and assuming the actual evaporation is 8.5 lbs., what is the equivalent evaporation from and at 212 deg. per lb. coal.

Multiply 8.5 by 1.135. Above 8.25 on top slide find 9.65 on top scale.



LIGHTING IN TORONTO.

Tenders for street lighting in Toronto were opened on October 4th. The Toronto Electric Light Company were the only tenderers for electric lighting. The price paid at present for arc lights is 20½ cents per night, or $74.82½ per year, and the prices named in the new tender are:

Open arc, for five year contract, 19 cents per night, $69.55 per year; ten year contract, 17¾ cents per night, $64.79 per year; an increase in the number of lamps to more than 1,750 to reduce the price to $62.50.

Closed arc, five year contract, 17¾ cents per night, or $64.79 per year; ten year contract, 16½ cents per night, or $60.23 per year; an increase in the number of lamps to more than 1,750 to reduce the price to $57.49.

The city is paying at present for its gas lighting $32 per year per lamp, and the new tenders were as follows:

No. 1—Incandescent mantle, 60 candle power, $28.60; with reflector, 80 candle power, $28.60; iron posts, $33.

No. 2—Incandescent mantle, with or without reflector, 60 candle power, $28; 45 candle power, $26.

No. 3—Incandescent mantle, 70 candle power, $27; if gas is supplied at 80 cents a thousand, $25.50.

The present electric lighting contract expires at the end of this year and the gas contract on June 30, 1906.

INTERFERENCE OF BUILDINGS WITH ELECTRIC WIRES.

WINNIPEG, MAN., October 7th, 1905.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—Noticing with interest the remarks in your September issue as to house moving interfering with wires, I thought it might be of interest to some who are suffering through this to give an idea of how we have met the difficulty here. I therefore enclose a copy of the by-law of the City of Winnipeg covering this point.

Before the passing of this law we (both the City Electrical Department and the various electrical companies) were much inconvenienced in many ways. We find, however, now that we have got some protection, that the question can be dealt with much better when brought under control.

Not only is the house moving without proper supervision a nuisance to those owning wires, but it is liable to prove a very dangerous element, as has been demonstrated on several occasions.

Yours truly,

F. A. CAMBRIDGE,

City Electrician.

BY-LAW NO. 3069.

A By-law of the City of Winnipeg for regulating the removal of buildings and structures on or across the streets and for regulating house movers.

The Municipal Council of the City of Winnipeg in Council assembled enact as follows:—

1. No building or structure shall be moved on or across any street of the City of Winnipeg except in compliance with and subject to the conditions of this By-law. When any person or persons desire to move a building or structure from one part of the City to another, involving going on or crossing a street, an application shall be made for a permit therefor to the City Engineer. Such application shall identify the building or structure to be moved and shall also indicate the route to be taken.

2. If the place to which it is intended to remove such building or structure is within the limits within which such class of buildings may be erected, a permit may be granted for removal. The City Engineer is to ascertain the character of the building, and to determine any question as to the Fire Limits may ask a report from the Building Inspector, who shall as soon as possible furnish same.

3. The Engineer shall ascertain whether any electric street railway, power, telegraph or telephone companies' wires or the wires of the City, may be affected by the removal of such buildings, and if it seems that they may be so affected, he shall direct notice to be given such interested Companies and the City Electrician of the application and of the time allowed for the removal of the building. It shall be the duty of the person obtaining such license before commencing to move any such building to notify the City Electrician and Company aforesaid whose wires may be interfered with by such removal of the time when he proposes to commence such removal so that such City or Company may have the necessary men on hand to protect, alter or remove their wires.

4. The City Engineer shall make an estimate of the amount necessary to recoup the City and the Companies whose wires may be affected for the cost of repairs to such wires, and for the wages of the men necessary to accompany said building during its removal to protect such wires, and in such estimate shall be incluced such sum as the City Engineer thinks necessary to repair injuries done to the City's pavement, and also to any wires or overhead constructions belonging to the City itself. In all cases the applicant shall pay not less than the sum of five dollars before obtaining their permit, and any sum additional thereto which the City Engineer shall determine is necessary for the purposes above mentioned, and such sums shall be held and paid by the city to re-imburse the said Company and the City itself for any damages to their or its wires caused by such removal and for any expense incurred in protecting such wires against damage during such removal, and any surplus after paying said amounts may be returned by the City to the person who paid the same.

5. No house-mover or other person shall drive any iron, wooden or other stake or spike or anchor or other instrument into or through the pavement of any street.

6. No house or other structure shall be moved on or across a street until a permit of the City Engineer has been issued, and such permit shall not be issued until the cash deposit ascertained as aforesaid has been made and the other pre-requisitions of this By-Law compiled with.

7. No house mover shall leave any building in the line of any wires, lamps or cables, but such moving shall be continuous until the building is perfectly clear of the wires, lamps or cables.

8. No building shall be left standing so as to prevent access to any fire alarm box, or to interfere with any street lamp, or so as to prevent the passage of any fire engine, hose reel or other fire apparatus.

9. No house mover shall break, cut, remove or interfere with any wire or wires, cable or appliances, the property of any Company, or the City, operating any system of telegraph, telephone, electric light, electric street railway or power. All necessary removing or cutting of wires necessitated by the moving of any building shall be done by the duly authorized workmen of the owners of such wires, and it shall be the duty of the City or any Company whose wires are or are likely to be affected by any such moving, being duly notified by the licensee as aforesaid, to have competent workmen in attendance during such moving who shall take all necessary precaution to prevent accidents or injury to the public, both in the use of the streets and highways and otherwise, and to prevent any damage to any building other than the building being removed.

THE NIAGARA DAM.

TORONTO, ONT., September 23rd, 1905.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—Your September issue contains a brief description of a concrete dam that is to be built by the Queen Victoria Park Commissioners, to raise the level of the water in the waterworks intake, the intention being to build a "concrete tower with chains embedded in it, the tower to be upset into shallow water, where it will lie on the bottom, forming a submerged dam. When it falls into the river the sections will break apart, so that the dam will conform to the bed of the river, while the chains will hold them in line."

Now, will there be any permanency to such a structure, and is there any surety that it will act as intended? If it is to conform to the river bed it will necessarily need to be largest where the river is deepest, and if this is not done then the crest of the dam will be above the water at one point and below it at some other point, that is, there will be too much dam at one place and not enough at another.

Any additional material to correct this would not be chained to the original mass, and would be in danger of being carried away.

Then again, it is natural to suppose the stream to be the most rapid and destructive at the point of end of proposed dam, and this would be intensified by the dam itself. It is thus very likely that a furious current around the end of this dam would cause the outermost blocks to move and to tug at their chains, and with some assistance from ice the result would be disintegration.

This seems an irrational piece of engineering, and a little thought should involve a better plan. If two towers were built with cross struts and diagonals, all well reinforced with very mild steel rods, then the bracing would prevent the outer blocks from being carried away, and a qnadrangle would be formed into which other blocks could be deposited to make the structure secure, and a uniform crest line could be obtained.

Or again, an A frame could be let down with a derrick, the lower ends being securely held to the bank, and the outer end could be provided with a heavy rest block, other A frames could be let down to fit to the first one, then the interior space could be filled in with hollow concrete blocks fitting to each other or laid in rows on end between timbers, and the interior of these blocks could be filled in with concrete.

Many such ways could be devised that would be positive engineering that would be superior to the single tumbling tower referred to.

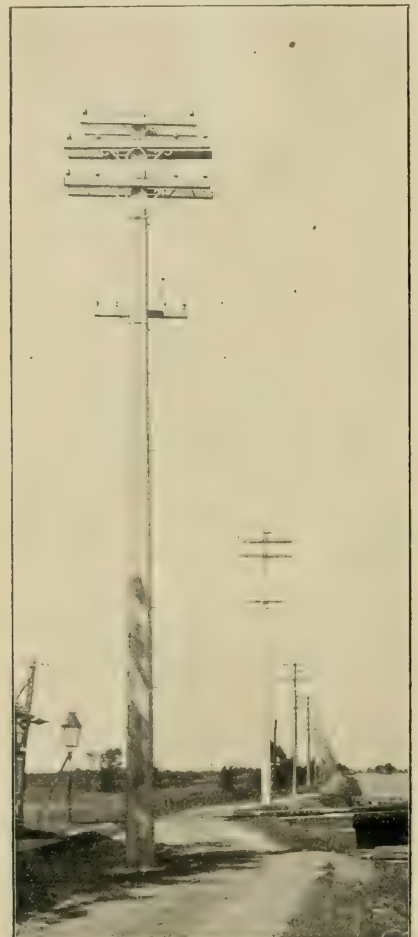
Yours truly,

JNO. S. FIELDING, C. E.

REINFORCED CONCRETE POLES.

The various electric transmission companies which have been organized within the past few years to transfer the energies of Canada's large and numerous water powers for hundreds of miles from the power producing plants have been, and are yet, in a state of uncertainty as to what style of support is best adapted for these long lines.

The cedar poles, which formerly could be procured at a small price, and of almost any dimensions, are becoming a thing of the past, being of an inferior quality, high in price and difficult to obtain. In addition to this



Reinforced Concrete Poles on Welland Canal Transmission Line.

the cedar poles require to be set very closely together, as their strength is not sufficient to carry the heavy wires used unless short spans are adopted. The adoption of short spans means large numbers of cross-arms and insulators, which would not be required on longer spans, and as the insulators are the weak points in long distance transmission, where continuity of service is absolutely necessary, it is very important that the number should be limited to the fewest possible.

When the spans are increased in length, it becomes necessary to use stronger poles, and various styles of steel structures have been designed for the purpose and spans as long as 400 feet erected upon them. Steel poles have the disadvantage of being costly and require considerable expense in maintenance. Wide base towers which have been used instead of poles on account of cheapness have the further disadvantage of taking up considerable width of right of way, and being necessarily built of light material, will not have the same length of life.

Mr. J. L. Weller, Mem. Can. Soc. C. E., Superintending Engineer of the Welland Canal, conceived the idea of a reinforced concrete pole to take the place of cedar and steel. The idea seemed so preposterous, however, that it was over two years after its first conception that the first pole was made. This was a failure on account of faulty reinforcement, and it was not until the third or fourth trial that a substantial pole was made, nearly two years ago. This pole when tested was so satisfactory that others were immediately built, and to-day there are nearly one hundred poles erected on the Welland Canal electrical transmission line.

Reinforced Concrete Poles—Do not Require Guying or Bracing on Curves. Special Bases on these Poles.

Some of these are shown in the accompanying illustrations. All the cedar poles for the line and two hundred steel poles 35 feet in height had already been contracted for by that time, consequently the concrete poles were used only in positions such as railway and road crossings where an extra high pole was required.

The poles are manufactured on the ground with their butts immediately over the hole in which they are to be erected, as it has been found very expensive to transport them on account of their great weight; a 35 foot pole for ordinary line work weighing about two and one half tons, and a 50 foot one about five tons.

Most of the poles so far made have been calculated to stand a horizontal pull at the top of 2,000 pounds, and tests that have been made show that the calculations have been correct, all standing the full load without any impairment, except one, which failed at 2,025 pounds, the cause being a flaw in the weld on one of the steel rods.

All poles have been made square, with the corners champered off, on account of ease in making and also on account of the saving in steel over any other section, each rod doing double duty, that is to say, if a pole is strained in one direction, rods A and B take up the tension, and if strained at right angles to the first direction rods B and C take up the strain, rod B thus

acting twice. The steel reinforcement is figured on the fact that the stresses in a pole from a horizontal pull at the top gradually increase from the top downwards, the leverage increasing directly with the distance from the point of pull. The theoretical reinforcement would, therefore, be a rod tapering from nothing at the top to a certain diameter, depending on the strain, at the bottom. As these tapering rods are

Concrete Poles have a Pleasing Appearance.

not rolled at present, the same effect is obtained as nearly as possible by welding different sized rods together, the diameter increasing by an eighth of an inch about every ten feet. Several trials were made to overcome the necessity of welding the rods, but hook joints or lapping the bars over each other at the junction gave very poor results, and all rods are now welded into one rod the full length of the pole.

The poles are moulded in wooden forms, in a horizontal position, the top side being left open and finished with a trowel. Foot steps are imbedded in the soft concrete as the pole is being made and bolts for cross-arms also, or holes are left so that a bolt may afterwards be put right through the pole. The concrete is composed of a 1:2:4 mixture, using the best Portland cement and clean sand and finely broken stone. Gravel has been used with success, in fact most of the poles so far have been built with gravel instead of broken stone.

Concrete poles are quite elastic, as is shown in one of the illustrations herewith, a pole 40 feet above the ground bending 12 inches under a strain of 2,000 pounds at the top. They do not require painting, being of a pleasing grey color, which, of course, will last indefinitely. They should last forever, as the weather is claimed to have no effect whatever on them. As there is some question about this latter assertion, attention may be drawn to a good granolithic sidewalk, which, if properly built, shows no signs whatever of age after 25 years, and a sidewalk during the spring, fall and winter is under much more serious stresses of weather than a pole could possibly be. Therefore,

Notice the Bend in this Pole, which was not Designed to Stand the Heavy Strain of 18 Wires at a Sharp Angle and will have to be Guyed.

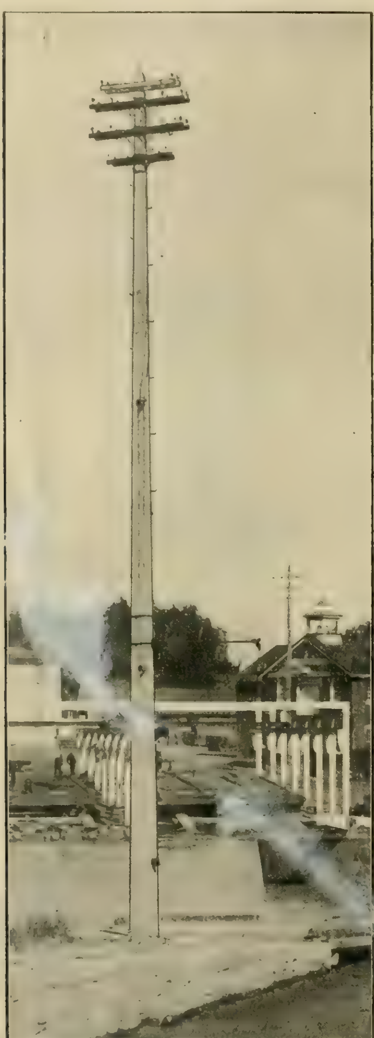
there seems to be no reason why the concrete pole may not be the pole of the future. They can be built of any desired height or strength.

Arrangements are now being concluded for the building and erection of two poles 150 feet in height at St. Catharines to carry wires over the old Welland

canal for the Lincoln Electric Light and Power Company.

The erection of the poles, especially such large ones as those mentioned above, which weigh about fifty tons each, is quite a serious matter, but they are being put up with very little trouble now, although at first several were broken through defective tackle.

The cost of these poles will depend on local conditions somewhat, and upon the specifications, as different users have different ideas as to the strength a pole should have for line work. As a general rule, however, the cost may be taken as about 25 per cent. less than that of a steel pole of similar strength.



70 Foot Concrete Pole Carrying Wires Over a "Slip" at Port Dalhousie.

To make these poles completely fire and time proof, concrete cross-arms would be a step forward, and these are now being experimented with.

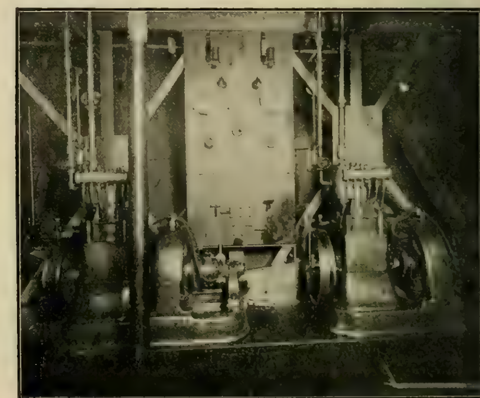
In cities where wooden trolley poles are not allowed, reinforced concrete poles should soon replace other forms, as they present a better appearance, are cheaper than steel, and will not rust off at the ground line as steel poles do.

Mr. Weller has patents granted or applied for in nearly every country in the world. He has disposed of his Canadian patent to the Concrete Pole Company, Limited, of St. Catharines, Ont.

ELECTRIC EQUIPMENT OF A FERRY BOAT.

Professor A. J. MacLean, naval architect, of New York, was commissioned by the City Council of St. John, N. B., to prepare plans for a steel ferry boat to ply between the cities of St. John and Carleton, N. B The contract for building same was awarded to Mr. James Fleming, of the Phœnix Foundry, while the installation of the electrical plant and equipment was carried out by Mr. Frank P. Vaughan, electrical engineer and contractor, St. John.

The length of the boat is 140 feet. The generating plant consists of two 4 k.w., 110 volt dynamos, 600 r.p.m., made by the Canadian General Electric Company and each direct connected to a single cylinder, $4\frac{1}{4} \times 4$ in., upright high speed engine, the steam connection being arranged for 80 pounds pressure. The commercial efficiency of the dynamos is guaranteed to be not



Electric Plant in Ferry Steamer "Ludlow," St. John, N. B.

less than 80.5 per cent., and the specifications provided that the voltage should not exceed 115 nor be less than 110 between full load and no load.

The main switchboard is of slate $1\frac{1}{4}$ inches thick mounted on an iron frame, with two positive busbars and one negative busbar permanently connected at the back and so arranged that the dynamos may be operated either separately or together on light circuits. The instruments consist of two double pole double switches, two automatic circuit breakers, two ammeters and one voltmeter of Western round pattern, two dynamo field rheostats, one six point voltmeter switch and double pole switches for hold circuits. There is also a distributing panel of slate $1\frac{1}{4}$ inches thick, enclosed in wooden frame.

The two-wire system is used throughout the boat, but provision has been made to light the signal lamps and about 25 per cent. of the cabin lamps in case of break down of one of the generators by using a common return negative. In the hold and centre house the conductors are run in iron armored insulated conduits, while between the centre house and cabin the conductors are carried in mouldings, and in the cabins, pilot houses and all concealed places in circular loom.

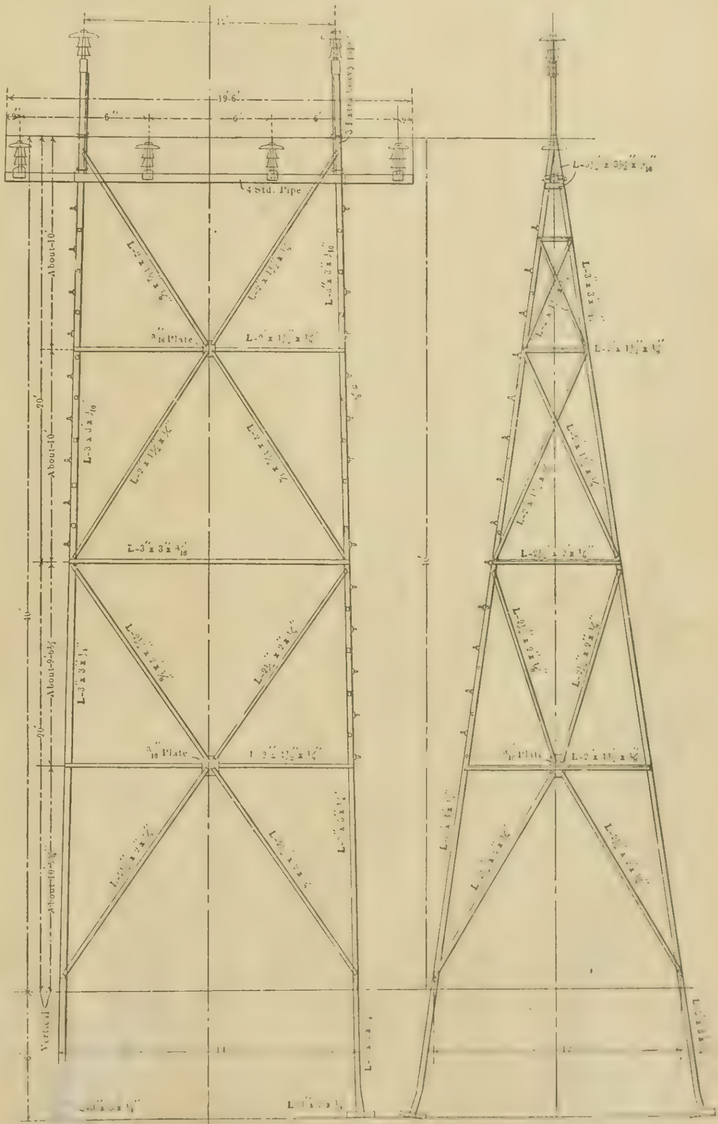
While embodying no special features, the electrical equipment is very substantial and complete and in keeping with the general character of the boat.

THE USE OF STEEL TOWERS AND WOODEN POLES

Steel towers are rapidly coming into use for the support of electric transmission lines that deliver large units of energy at high voltages to long distances from water powers.

One case of this sort is the seventy-five-mile transmission of 40,000 horse-power at 60,000 volts from Niagara Falls to Toronto, for which a line with steel towers is now nearing completion. Another example may be seen in the seventy-five-mile line of steel towers which carries transmission circuits of 60,000 volts to Winnipeg. Guanajuato, Mexico, which is said to have produced more silver than any other city in the world, receives some 3,300 electric horse-power over a 60,000 volt transmission line 100 miles long on steel towers. Between Niagara Falls and Lockport the electric circuits now being erected are supported on steel towers. On a transmission line eighty miles long in northern New York, for which plans are now being made, steel towers are to support electric conductors that carry current at 60,000 volts.

For the elevations above ground at which it is common to support the conductors of transmission lines, that is from thirty to fifty feet, a steel tower will cost from five to twenty times as much as a wooden pole in various parts of the United States and Canada. It follows at once from this fact that there must be cogent reasons, apart from the matter of first cost, if the general substitution of steel towers for wooden poles on transmission lines is to be justified on economic grounds. During fifteen years the electric transmission of energy from distant water powers to important centres of population has grown from the most humble beginnings to the delivery of hundreds of thousands of horse-power in the service of millions of people, and the lines for this work are supported with very few exceptions on wooden poles. Among the transmissions of large powers over long distances at very high voltages that have been in successful operation during at least several years with wooden pole lines are the following: The 60,000-volt circuit that transmits some 13,000 horse-power from Electra station across the state of California to San Francisco, a distance of 147 miles, is supported by wooden poles. In the same state the transmission line is 142 miles long between Colgate power-house and Oakland, at 60,000 volts and with a capacity of about 15,000 horse-power, hangs on wooden poles, save at the span nearly a mile long over the straits of Carquinez. Wood is used to carry the two 55,000-volt circuits that run sixty-five miles from the 10,000 horse-power station at Canon Ferry on the Missouri river to Butte. Between Shawinigan Falls and Montreal, a distance of eighty-three miles, the conductors that deliver at least 6,000

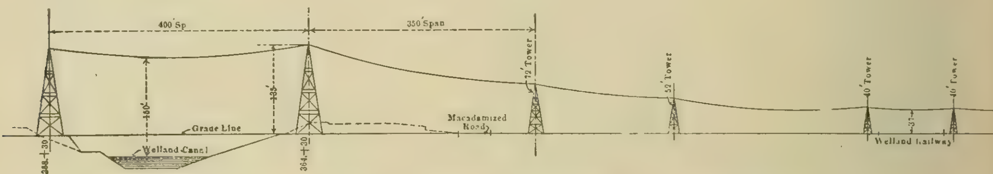


Steel Towers for the Niagara Falls and Toronto Transmission Line.

horse-power are carried on wooden poles. Electrical supply in Buffalo to the amount of 30,000 horse-power depends entirely on circuits from Niagara Falls that operate at 22,000 volts and are supported on lines of wooden poles.

In the operation of these and many other high-voltage transmissions during various parts of the past decade some difficulties have been met with, but they have not been so serious as to prevent satisfactory service. Nevertheless, it is now being urged that certain impediments that are met in the operation of transmission systems would be much reduced by the substitution of steel towers for wooden poles, and it is even suggested that perhaps the first cost, and probably the last cost, of a transmission line would be less with steel than with wood for supports. The argument for steel in the matter of costs is that while a tower requires a larger investment than a pole, yet the smaller number of towers as compared with that of poles may reduce the entire outlay for the former to about that for the latter. More than this, it is said that the lower depreciation and maintenance charges on steel supports will make their final cost no greater than that of wooden poles.

In the present state of the market, steel towers can be had at from three to three and one-half cents per pound, and the cost of a steel tower or pole will vary to smaller sizes, and is braced at frequent intervals The height of these towers is forty-nine feet, and the weight of each is 2,800 pounds. At three cents per pound the cost of each tower amounts to eighty-four dollars. For a long transmission line in northern New York bids were recently had on towers forty-five feet high to carry six wires, and the resulting prices were $100 to $125 each for a tower weighing about 3,000 pounds. On the seventy-five-mile line between Niagara Falls and Toronto the standard height of steel towers is forty feet from the ground level to the point where the two legs of each side join, and to this must be added a length of six feet that goes into the ground, and about three feet of pipe that run up from the junction of each pair of legs at the top, giving a total length of forty-nine feet exclusive of insulator pins. Except as to a cross-arm of standard four-inch steel pipe, and the two uprights of extra heavy three-inch pipe at the top, this tower is built up almost entirely of L sections that vary from $3'' \times 3'' \times \frac{1}{4}''$ to $2'' \times 1\frac{1}{2}'' \times \frac{3}{8}''$. The weight of this tower is very close to 2,360 pounds, and its cost at three cents per pound would amount to about seventy dollars. Ou the line of these towers there are strung six hard-drawn copper cables with a cross-section of 190,000 circular mils each. Between these standard towers the maximum spacing is 400 feet, but this length of span is much reduced on curves and where



PROFILE OF NIAGARA FALLS AND TORONTO TRANSMISSION LINE AT WELLAND CANAL.

nearly as its weight. During the first half of 1904 the quotations on tubular steel poles to the Southside Suburban Railway Company, of Chicago, were between the limits just stated. That company ordered some poles built up of steel sections about that time at a trifle less than three cents per pound. Each of these poles was thirty feet long and weighed 616 pounds, so that its cost was about eighteen dollars (xxi, A. I. E. E., 754). For a forty-five-foot steel pole to carry a pair of 11,000-volt, three-phase circuits along the New York Central electric road the estimated cost was eighty dollars in the year last named (xxi, A. I. E. E., 753). On the 100-mile line to Guanajuato, Mexico, above mentioned, the steel towers were built up of 3 in. x 3 in. x 3/16 in. angles for legs, and were stayed with smaller angle sections and rods. Each of these towers has four legs that come together near the top, is forty feet high, weighs about 1,500 pounds, and carries a single circuit composed of three No. 1 B. & S. guage hard-drawn copper cables. The weight of each of these cables is 1,340 pounds per mile, and the forty-foot towers are spaced 440 feet apart, or twelve per mile, over nearly the entire length of line. At three cents per pound, the lowest figure at which these towers could probably be secured for use in the United States, the approximate cost of each would be forty-five dollars. Between Niagara Falls and Lockport each of the steel towers that is to carry a single three-phase transmission circuit has three legs built up of tubing that tapers from two and one-half inches the ground is uneven, so that about 1,400 towers are used on the seventy-five-mile line, which gives an average spacing of 283 feet.

In January, 1902, four steel towers were purchased to support transmission circuits for two spans of 132 feet each over the Chambly canal, near Chambly Canton, Quebec. Each pair of these towers was required to support eleven No. 2/0 B. & S. gauge bare copper wires with the span of 132 feet between them. The vertical height of each of these four towers is 144 feet above the foundation, and they were designed for a maximum stress in any member of not more than one-fourth of its ultimate strength, with wires coated to a diameter of one inch with ice and under wind pressure. For these four steel towers erected on foundations supplied by the purchasers the price was $4,670, and the contract called for a weight in the four towers of not less than 121,000 pounds. On the basis of this weight the cost of the towers erected on foundations was 3.86 cents per pound.

With these examples of the cost of steel towers a fair idea may be got of the relative cost of wooden poles. For poles of cedar or other desirable wood thirty-five feet long and with eight-inch tops fitted with either one or two cross-arms an estimated cost of five dollars each is ample to cover delivery at railway points over a great part of the United States and Canada. This size of pole has been much used on the long, high-voltage transmission systems that involve large power units and use heavy conductors. Ex-

amples of lines where such poles are used may be seen between Niagara Falls and Buffalo, between Colgate power-house and Oakland, and between Canon Ferry and Butte. Of course some longer poles were used in special locations, like the crossing of steam railways, but it is also true that on the lines supported by steel towers such locations make exceptionally high towers necessary. The thirty-five foot poles will hold the electric lines about as high above the ground level as the forty-nine-foot towers on the Niagara Falls and Toronto transmission, because the former will be set so much closer together. On the line just named the regular minimum distance of electric cables above the ground level at the centres of spans is twenty-five feet. The standard towers on this line carry the lower electric cables forty feet above the ground at the insulators, and it was thought desirable to allow a sag of fifteen feet at the centres of the regular spans of 400 feet each. On these towers the couductors that form each three-phase circuit are six feet apart, and the lines drawn between the three cables form the sides of an equilateral triangle. With a pin fourteen and three-fourths inches long like that used on these steel towers, and one conductor at the top of a thirty-five-foot pole, where the other two are supported by a cross-arm five feet three inches below, giving six feet between cables, the lower cables are held by their insulators twenty-six feet above the ground, when the poles are set five feet deep. Between thirty-five-foot poles 100 feet is a very moderate span, and one that is exceeded in a number of instances. Thus on the 142-mile line from Colgate power-house to Oakland the thirty-five-foot poles are 132 feet apart, and one line of these poles carries three conductors of 133,000-circular-mil copper, while the other pole line has three aluminum cables of 168,000 circular mils. On the later transmission line from Niagara Falls to Buffalo, which has one three-phase circuit of 500,000-circular-mil cable, the regular distance between the thirty-five-foot poles is 140 feet.

A maximum sag of twenty-four inches between poles 100 feet apart under the conditions named above brings the lowest points of the electric cables twenty-four feet above the ground. The steel towers on the line to Guanajuato being only forty feet in length, and spaced 440 feet apart, it seems that the distance of conductors from the ground at the centres of spans is probably less than that just named. Particular attention is called to this point because it has been suggested that the use of steel towers would carry cables so high that wires and sticks could not be thrown onto them. It thus appears that thirty-five-foot wooden poles set 100 feet apart will allow as much distance between conductors, and still keep their lowest points as far above the ground, as will forty to forty-nine-foot towers placed 400 feet or more apart. The two lines that have their conductors further apart perhaps than any others in the world are the one from Canon Ferry to Butte, on thirty-five-foot wooden poles, and the one to Guanajuato, on steel towers. In each of these cases the cables are seventy-eight inches apare at the corners of an equilateral triangle. With steel towers 400 feet or wooden poles 100 feet apart, four of the latter must be used to one of the former. At $5 per pole this requires an investment of $20 in poles as compared with at least $45 for a tower like those on the Guanajuato line, $84 for a tower like those on the line from Niagara Falls to Lockport, or $60 for one of the towers on the Niagara and Toronto line. Each of the towers on the line to Toronto carries two three-phase circuits, and the least distance between cables is six feet. To reach the same result as the distance between conductors with the two circuits on poles, it would be desirable to have two pole lines, so that $40 would represent the investment in the poles to displace one tower for two circuits. The older pole line between Niagara Falls and Buffalo carries two three-phase circuits on two cross-arms, and the 350,000-circular mil copper cables of each circuit are at the angles of an equilateral triangle whose sides are each three feet long. In this case, however, the electric pressure is only 22,000 volts.

The costs above named for poles and towers include nothing for erection. Each tower has at least three legs and more commonly four, and owing to the heights of towers and to the long spans they support, it is the usual practice to give each leg a footing of cement concrete. It thus seems that the number of holes to be dug for a line of towers is nearly or quite as great as that for a line of poles, and considering the concrete footings the cost of erecting the towers is probably greater than that for the poles. With wooden poles about four times as many pins and insulators are required as with steel towers, or say twelve pins and insulators on poles instead of three on a tower. For circuits of 50,000 to 60,000 volts the approximate cost of each insulator with a steel pin may be taken at $1.50, so that the saving per tower reaches not more than $13.50 in this respect. In the labor of erecting circuits there may be a small advantage in favor of the towers, but the weight of the long spans probably offsets to a large extent any gain of time due to fewer points of support.

An approximate conclusion from the above facts seems to be that a line of steel towers will probably cost from 1.5 to twice as much as a line or lines of wooden poles to support the same number of conductors the same distance apart, even when the saving of pins and insulators is credited to the towers. This conclusion applies to construction over a large part of the United States and Canada. It is known that wooden poles of good quality retain enough strength to make them reliable as supports during ten or fifteen years, and it is doubtful whether steel towers will show enough longer life to more than offset their greater first cost. It may be noted here that any saving in the cost of insulators or other advantage that there may be in spans 400 feet or more long can be as readily secured with wooden as with steel supports. With these long spans the requirements are greater height and strength in the line supports, and these can readily be obtained in structures, each of which is formed of three or four poles with cross-braces. Such wooden structures have long been in use at certain points on transmission lines where special long spans were necessary, or where there were large angular changes of direction. In those special cases where structures 75 to 150 or more feet in height are necessary to carry a span across a waterway, as at the Chambly canal above mentioned, steel is generally more desirable than wood because poles of such lengths are not readily obtainable. Neither present proposals nor practice, however, contemplates the use of steel towers having a

length of more than forty to fifty feet on regular spans.

Much the strongest argument in favor of steel towers for transmission lines is that these towers give a greater reliability of operation than do wooden poles. It is said that towers will act as lightning-rods and thus protect line conductors and station apparatus As to static and inductive influences from lightning it is evident that steel towers can give no protection. If each tower has an especial ground connection it will probably protect the line to some extent against direct lightning strokes, but there is no reason to think that this protection will be any greater than that given by well grounded guard wires, or even by a wire run from a ground plate to the top of each pole or wooden tower. If a direct lightning stroke passes from the line conductors to a wooden support it frequently breaks the insulator on that support, and the pole is often shattered or burned. Such a result does not necessarily interrupt the transmission service, however, as the nearby poles can easily carry the additional strain of the line until a new pole can be set. Quite a different result might be reached if lightning or some other cause broke an insulator on a steel tower, and thus allowed one of the electric cables to come into contract with the metal structure, as the conductor would then probably be burned in two. To repair a heavy cable thus severed where the spans were as much as 400 feet long would certainly require some time. Where a conductor in circuits operating at 20,000 to 35,000 volts has in many cases dropped onto a wooden cross-arm, it has often remained there without damage until discovered by the line inpector, but no such result could be expected with steel towers and cross-arms (xxi, A.I.E.E., 760.) Where steel towers are employed it would seem to be safer to use wooden cross-arms, for the reason just stated. This is, in fact, the practice on the steel towers before named, that support 25,000-volts circuits over the Chambly canal, and also on the steel towers that carry the 60,000-volt circuits from Colgate powerhouse over the mile-wide straits of Carquinez.

On the 40,000-volt transmission line between Gromo and Nembro, Italy, where timber is scarce and steel is cheap, both the poles and cross-arms are of wood. It is thought that the comparatively small number of insulators used where a line is supported at points about 400 feet apart should contribute to reliability in operation, but insulators now give less trouble than any other part of the line, and the leakage of energy over their surfaces is very small in amount, as was shown in the Teleuride tests. Whatever benefits are to be had from long spans are as available with wooden as with steel supports, and at less cost.

One advantage of steel towers over wooden poles or structures is that the former will not burn, and are probably not subject to destruction by lightning. Where a long line passes over a territory where there is much brush or timber the fact that steel towers will not burn may make their choice desirable. In tropical countries where insects rapidly destroy wooden poles the use of steel towers might be highly desirable even at much greater cost, and such a case was perhaps presented on the line to Guanajuato, Mexico.

Mechanical failures of wooden insulator pins have been far more common than those of poles, both as a direct result of the line strains, and because such pins are often charred and weakened by the leakage of energy from the conductors. For these reasons the general use of iron or steel pins for the insulators of long lines operating at high voltages seems desirable. Such pins are now used to support the insulators on a number of lines with wooden poles and cross-arms, among which may be mentioned the forty-mile, 30,000-volt transmission between Spier Falls and Albany, and the forty-five-mile 28,000-volt line from Bear river to Ogden, Utah. Iron or steel pins add very little to the cost of a line, and materially increase its reliability. One of the cheapest and best forms of steel pins is that swaged from a steel pipe, and having a straight shank and tapering stem with no shoulder. A pin of this sort for the 400-foot spans of 190,000-circular-mil copper cable on the line from Niagara Falls to Toronto measures three and one-quarter inches long in the shank, eleven and one-half inches in the taper, and has diameters of two and three-eighth inches at a larger and one and one-eigth inches at the smaller end.

On long transmission lines where the amount of power involved is very large, the additional reliability to be had with steel towers is probably great enough to justify their use. For the great majority of power transmissions, however, it seems probable that wooden poles or structures will long continue to be much the cheaper and more practical form of support.—Alton D. Adams, in Electrical Review.

WESTINGHOUSE SINGLE PHASE RAILWAY SYSTEM.

A contract awarded to the Westinghouse Electric & Mfg. Company by the New York, New Haven and Hartford Railway for twenty-five electric locomotives is another victory for the alternating current system and conclusive evidence of its success in the field of electrical transportation. Each of these locomotives will weigh approximately 78 tons and in local service with a 200-ton train will attain a speed of 45 miles an hour, while a speed of 60 to 70 miles an hour with a 250-ton train will be maintained in express service. To handle heavier trains two or more locomotives will be coupled together and will be controlled from the forward cab. The multiple control system which forms part of the equipment makes it possible for a single engineer or driver to operate several locomotives coupled together just as easily and accurately as he can handle one.

One of the valuable characteristics of the Westinghouse single-phase motor is that it may be employed on either the alternating or direct current system and it has therefore been possible for the officials of the railway company to select the most advanced and economical system for the operation of their lines, and at the same time to accommodate their equipment to the direct-current system now being installed by the New York Central Railroad, as the New York, New Haven & Hartford Railroad utilizes the tracks of the latter company between Woodland and the Grand Central Depot in New York city. For a time the service will be confined to this section and it is therefore with an eye to the future rather than present requirements that the alternating current system has been adopted.

Each locomotive will be equipped with four Westinghouse single-phase railway motors of the straight series gearless type and with the unit switch system of multiple control. On direct current each motor will be capable of developing a rated output of 400 horsepower.

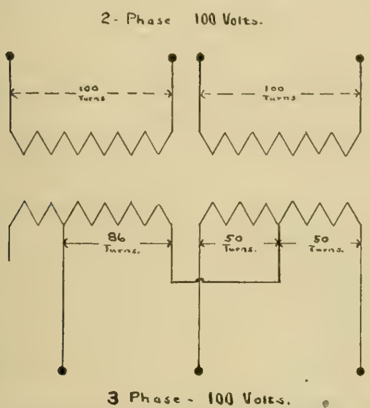
QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. No. 1.—Will you please send me a diagram and some particulars of the Scott system of joining up transformers so as to convert a two phase into a three phase current?

ANS.—We show herewith a rough sketch illustrating the Scott method of transforming two to three phase current by means of two transformers. The sketch



SCOTT CONNECTIONS FOR TRANSFORMERS.

shows a transformation of phase only and not voltage, that is to say, the primary and secondary voltages are identical. However, the ratio will hold good for any desired primary voltage provided the number of turns shown in the sketch is increased or decreased in the same proportion that the primary voltage is increased or decreased, this same rule applying to the secondary also. There are certain electrical companies who furnish in all their large transformers, coils having a terminal brought out known as the .866 point. This is valuable when the transformers may be wanted for two to three phase work. As the Scott system consists of two phase generators, three phase transmission, and two phase distribution, such transformers are naturally used. The transformation may be accomplished, however, with two ordinary transformers, that is to say, transformers having standard taps. The transformer shown on the right hand side of the sketch will have a proper ratio of turns, but the left hand transformer in place of having eighty-six turns will have fifty turns and this will produce some unbalancing in the three phase voltage. This, however, is not so serious as to prevent standard transformers being used, and emergencies are very likely to arise where it is essential to use any kind of transformer available and under such circumstances standard transformers will temporarily give satisfactory results.

QUES. No. 2—What is meant by the "receiver" in connection with compound engines?

ANS.—The receiver is the connection between the high and low pressure cylinders. When the high pressure cylinder is exhausting, the steam is passed into the receiver, and from it in turn is delivered to the low pressure cylinder. Where the cranks of a compound engine are together or are one hundred and eighty degrees apart, the capacity of the receiver need not be large, as in this case it acts merely as a conductor of the steam from the high pressure to the low pressure cylinder. If, on the other hand, the cranks are ninety degrees apart, the receiver capacity should be much larger, authorities differing upon the exact size. For instance, Seaton says that the receiver capacity should be from one to one and a half times that of the high pressure cylinder, while another prominent engineer states that the capacity should not be less than that of the low pressure cylinder. With cranks ninety degrees apart, the receiver acts as a reservoir, and hence the necessity for its being larger than required with cranks one hundred and eighty degrees apart.

QUES. No. 3.—I have recently received a copy of a diagram showing the horse power which a manila rope is capable of transmitting at various speeds. The curves for various diameters increase rapidly in almost direct proportion to the velocity of the rope, but after reaching a certain point the amount of power which a rope of certain size is capable of transmitting seems to drop off in spite of the fact that the velocity is still further increased. Can you give me any explanation in connection with this matter?

ANS.—When figuring manila rope for power transmission purposes, the maximum working strain which the rope is capable of standing is always taken into consideration. Let us assume that for a certain size rope this is 500 pounds. Theoretically, if this rope travelled at 5,000 feet per minute, the foot pounds would be 2,500,000, which divided by 33,000 would give the horse power. However, when the rope is travelling over pulleys, centrifugal force comes into play, and this puts a strain on the rope in addition to that produced by the driving pulley. The greater the velocity of the rope the greater this strain due to centrifugal force. This centrifugal strain must be calculated, and must be deducted from the maximum working strain which the rope will stand. If, for instance, it be 200 pounds at 5,000 feet, it will leave available for power transmission in the above case but 300 pounds. You will notice from your table that the power of the rope does not increase in the same proportion as the velocity; this is because the centrifugal strain increases with the velocity, and hence at a certain point, the centrifugal strain will equal the total strain which the rope will stand, and hence there will be no margin for the transmission of power. This point is in the neighborhood of 140 feet per second, at which point the centrifugal strain will be equal to the maximum working strain.

QUES. No. 4.—I understand that a three phase generator can be operated as a single phase machine. Has this peculiarity any advantage and if so how much power can be obtained from a three phase generator when operated as a single phase machine?

ANS.—Probably the system which gives the best resluts so far as incandescent lighting is concerned is the single phase, and on the other hand, either two or three phase is most adaptable for power purposes. The three phase machine can be operated single phase and also three phase at the same time. This gives tbe three phase machine a decided advantage in small plants, as the lighting can be taken off single phase and the power taken off three phase, thus giving the best possible arrangement of circuits. As a single phase machine the three phase generator was approximately seventy-five per cent. of its three phase capacity. Where two or three phase lighting is used, difficulty may be experienced in balancing the phases, and regulators may have to be installed for the purpose. If the lighting be done from one phase of a three phase machine, this phase is the only one which will require watching, and as the voltage of this phase may be controlled without regard to the other phases, in all probability this system will give the most satisfactory results.

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Municipal Management. In a certain city in Western Ontario we have an example of municipal ownership in one of its worst phases. We have advocated in previous issues the placing of the control of the power plants owned by municipalities, in the hands of either a commission or an individual, and the results which have been produced in certain localities have proved our contentions along this line to be correct. In the city referred to, an alternating equipment was installed some years ago, the motive power being steam. The class of apparatus which comprised the plant would be considered obsolete to-day, but in its way it was quite satisfactory and no doubt gave comparatively economical results. The plant gradually increased until an enlargement became necessary and it was at this time that trouble began. Throughout Ontario there are installed many alternating current plants, varying in size from 20 to 60 kilowatts, the distributions being within a comparatively limited area. These equipments, in the general run of cases, have been installed for ten or fifteen years, and it is quite possible that at the time of installation the use of direct current was not duly considered. Alternating current was at that time in its infancy, and its possibilities were apparently so unlimited that the introduction was greeted with a good deal more enthusiasm than it deserved. The field in which alternating current apparatus should be used is one where the amount of power is comparatively large and where the area to be covered is also on a large scale. For the little plant, with a compact distribution, direct current undoubtedly offers the most economical proposition, but the line is clearly drawn and it is not difficult to decide between the two classes of machinery. Our western concern, however, being a municipality, conceived the idea that their alternating plant was a mistake, and therefore proceeded in the wildest possible way to throw out the old apparatus and install in its stead direct current machines. Two generators, each of 200 kilowatts capacity, were purchased and were connected in series for three wire distribution, the potential across the outside wires being five hundred volts. This, we must admit, was a step in the right direction, so far as the distribution was concerned, but why two generators of such large size were installed and connected in this way is more than we can understand. The service must be on a twenty-four hour basis, during six or eight hours of which the load would be infinitesimal, and all through this period both the generators must be operated to supply energy to the corporation. To our mind the most natural thing would have been to install a small 500 volt generator either of the three wire type or with a balancer set, and use this machine to carry the light load. However, as before stated, the arrangement adopted made it necessary to operate the two large generators continuously, and the best explanation which can be given for this curious piece of engineering is that it was done under municipal ownership.

No doubt some of the councillors had heard that the efficiency of the gas engine far exceeded the best figure which could be obtained from steam engines, and this brought to the front a proposition for driving the two generators previously mentioned by means of gas. After due deliberation four gas engines were

purchased, three of these machines having a capacity of one hundred and twenty-five horse power each, and the other eighty-five horse power. These engines were belted to a line shaft from which were driven the two two-hundred kilowatt generators. So far as mechanical operation was concerned, the plant was quite satisfactory, but it was not long before the corporation became aware of the fact that there was more money being spent in connection with the operation of the plant than was being received from the power consumers. This, it will be understood, was a rather serious matter, for the plant had been an expensive one to install and was so arranged that re-designing was practically out of the question. The matter, we understand, was then placed in the hands of a commission and outside assistance was employed in determining the coal operating cost of the plant and arriving at a conclusion as to the source of the trouble. So far as the generators were concerned, these machines were of high efficiency and completely fulfilled the excellent guarantees which had been given with them. The gas consumption of the engines was apparently all that could be desired. The line shaft of course required a certain amount of energy to drive it, but this was not a very serious consideration. The gas which was supplied to the engines was of a fair quality, but the great point was that this gas was costing the corporation about four times more to manufacture than was expected, and it seemed an almost impossible feat to reduce this cost. Therefore the members of the city council, after much argument, resolved upon another brilliant move, namely, that the gas engines should be thrown on the scrap heap and that substituted thereor should be steam engines of the Corliss type and boilers of modern make, such appliances having principles of operation which could be grasped by the lay mind. Gas engines cost much money, and therefore it is extremely doubtful if the Corporation would have saved one cent by this change, as they were increasing their plant cost, which was already extremely high, in order to get a decreased coal consumption, which, in all probability, they would not have obtained. However, common sense has at last ruled and they have decided to install a producer gas system. Certain members of the commission were instructed to visit and inspect various gas plants in the United States, and while the report which they submitted contains little or no information, still it may be taken whole as a favorable finding on the operation of American gas plants, but whether this report has any value from an engineering standpoint or not, the fact remains that it was adopted and the western city has made its first sensible move in the installation of producer gas. Their next step should be a modification of the electrical end, and this should be a matter of comparative simplicity. We should think that if a fifty kilowatt generator of the three wire type should be installed and so arranged that it may be driven by the eighty-five horse power gas engine, without running the line shaft, a very much better economy would be obtained from the plant as a whole. There are other similar modifications which can be made, and which will all tend to increase the economy of the plant. We sincerely hope that this city will come out of the deal on the right side, but we are inclined to think that if they should conscientiously figure the loss that has been entailed through mismanagement and improper handling, that an item of five figures at least would be placed on the debit side of their profit and loss account. And this is the city which scoffed at the idea of placing their work in the hands of a competent consulting engineer.

A great deal has been said in connection with municipal ownership in England, and figures have from time to time been placed before the public showing a really remarkable success as having come to the ventures which had been placed under the control of the local councillors. It has been stated upon good authority that two hundred and ninety-nine municipalities in England out of three hundred and seventeen have purchased businesses of various kinds and are running them under their own management. It is also stated that, not being satisfied to assume the control of one enterprise, each municipality has on the average assumed the responsibility of managing three and one-half undertakings each. It can be stated truthfully that the cost of running a business should not be more to a municipality than it is to either a private company or an individual, but with this statement must be considered the fact that the economy of any enterprise hinges directly upon its management, and therefore a proposition which may pay a private company a very handsome dividend may show a loss when placed under erratic municipal control. Due to this reason, a number of municipal enterprises in Canada have met with failure. England is looked upon as being the ideal country in which to conduct a municipal venture, but while the conditions may be ideal, still the fact remains that in placing operation cost before the public, items are omitted which should really be charged against the plant, and consequently the showing of any enterprise for a given year is apparently much better than the reality. We noted some months ago in these columns the figure given by the investigating committee in New York city in connection with the street lighting. It will be remembered that the men employed by the municipality to estimate the cost of lighting, if handled by a municipal plant, placed the figure at about sixty dollars, whereas the city was at that time paying in the neighborhood of one hundred and twenty dollars. Later it was found that several items were omitted from the cost of operation of the municipal plant, which had they been added, would have brought the total up to considerably over one hundred and forty dollars. We give emphasis to these facts to prevent misunderstanding in connection with municipal ownership. Great care should be taken in figuring the costs and the general public can be certain of one fact, namely, that it is extremely doubtful if a municipal plant can be operated more cheaply than the same plant under private ownership.

The Canadian Northern Coal & Ore Dock Company, Port Arthur, Ont., have recently purchased from the Robb Enginering Company, Limited, Amherst, N.S., one 300 h.p. Robb-Armstrong tandem engine.

The contract for the enlargement of the electric light plant of the corporation of St. Marys, Ont., was awarded on Wednesday, October 11th, by Mr. K. L. Aitken, consulting electrical engineer, Toronto. The entire equipment, consisting of a 150 k. w. revolving field generator, with panel, static transformers and series alternating street lighting system, will be supplied by the Canadian Westinghouse Company.

ELECTRIC TRACTION FOR RAILROAD SERVICE.*

By J. A. Shaw, Assistant Electrical Engineer, C. P. R., Montreal.

It is to-day generally admitted that, so far as the actual moving of trains is concerned, the electric motor can do the work better than the steam locomotive. But the more important question is, will it pay to convert steam roads to electric. This is best answered by the amount of such work which is now being carried out throughout the world, the results obtained and the advantages possessed by electric traction. These may be briefly enumerated as follows:

(1) Those appealing to the passenger, and the consequent increase in traffic.

(2) Those relating to the operating of trains from one central power house.

(3) The savings in capital, maintenance and operation.

The most noticeable to the passenger, namely, those affecting his comfort, are the cleanliness of the cars due to the absence of smoke and cinders, especially in tunnels, also the better distribution of heating and lighting made possible. Another factor is the higher speed attainable, not only for continuous runs, but with the same running speed as on a steam line, the average speed is higher and the duration of the trip reduced by the more rapid starting and stopping made possible by the increased traction due to the uniform rotary movement of motors. An additional gain in runs of considerable length would be in the abolition of stops for water or fuel.

The saving in the cost of generating power in a large central power house, with the refinements possible in steam generation and consumption as well as to the high load factor, is apparent especially as the cost of fuel increases at the more remote fuel stations on a steam road. An inferior grade of coal may also be used or if water power is available the cost of power will be very largely reduced. In spite of these advantages, it is questionable if a saving could be shown for electric traction in its present stage on a road with infrequent trains. Under present economical conditions, electricity is limited to a certain degree to large terminals, suburban lines, spurs to main lines, and mountain railways. However, the operation of through trunk lines will come shortly as the art advances and as the various water powers throughout the country are developed.

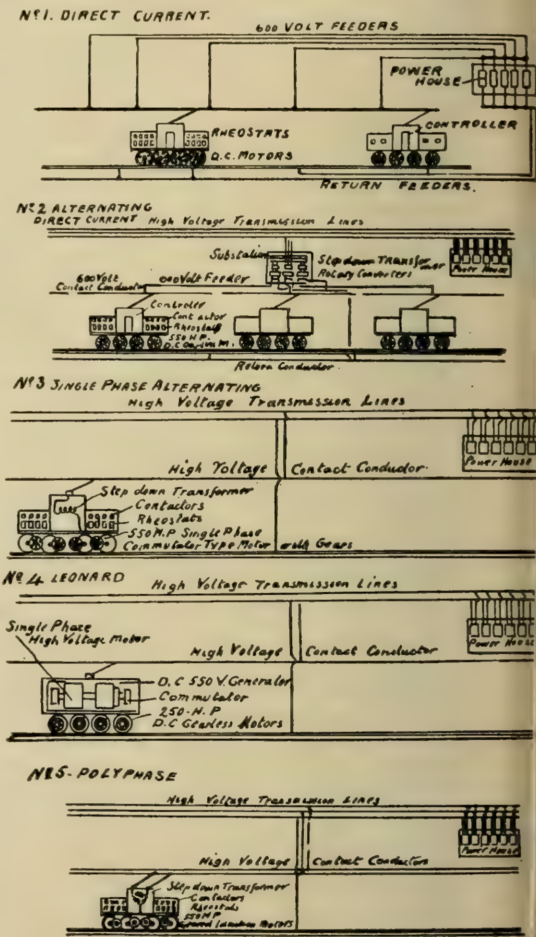
The cost of roadbed construction is in favor of electric traction, a higher grade being attainable and permitting of a shorter route. The equipment of an electric road is higher than the initial outlay for equipping the same road for steam operation; this difference is, however, counterbalanced by the larger outlay for terminal facilities and the cost of steam and water stations for a steam road.

Experience has shown that maintenance and operating expenses with electric traction are much lower than with steam. This applies specially as regards track up-keep, the roadway being subjected to less wear and tear, as there is no jumping, pitching or side-way oscillation. A road with heavy traffic and a large and efficiently operated power house should use only one-half as much coal as one using steam locomotives and this may even be reduced to one-third by the application of refinements made possible with large steam generating plants. This saving, it is stated, has been made by the Italian Mediterranean Railway. On another converted road it has been observed that the cost of lubrication is now less with electric traction, and the absence of smoke results in an important reduction in the cost of cleaning. The wages of train stafts on an electrically operated road can be materially reduced, as the engineer and fireman are replaced by a motorman who does not need to go through a long and complicated training and who consequently is not entitled to so high a rate. This saving in labor, however, is questionable practice, especially where a high speed schedule is in force.

Actual figures of the comparative cost of electric and steam roads, operating under similar conditions, are difficult of obtaining as yet. It has been determined by city elevated roads that the capacity of lines has been increased by one-third, and the operating expenses reduced from more than 55°/. to less than 45°/. of its gross receipts.

The Assistant General Manager of the North-Eastern Railway, England, stated recently in Washington, that his road had in self-defence converted a suburban service in order to regain traffic from competing tramways and to increase its amount. This they had successfully accomplished with a large increase in traffic with a resulting reduction in expenses, so that the net revenue now more than covers the interest on the extra cost of installation of new system.

The experience of another English railway, namely, the Lancashire and Yorkshire, has been somewhat similar. This railway adopted electric traction not primarily for the sake of economy but to increase receipts and decrease the crowding of terminals. During the twelve months the line has been operated electrically, there has been increase in traffic but the cost of operation has been more expensive. The cost of coal per ton mile is greater but the running expense less because of the greater mileage run by train crews. The introduction of electricity has increased the capacity of terminals 30 to 40 per cent., due to the elimination of the time lost in handling a train upon its arrival, the electric motorcars only requiring motormen to carry operating lever from one end of train to the other, and the



throwing of one or two switches is the only operation required for fitting the train for a run in the opposite direction.

Total combined operating expenses show a considerable reduction can be made in the cost of conducting transportation by the introduction of electric traction, but it is difficult to secure figures that will permit an exact analysis of each of the items which go to make up the saving.

At present there are, generally speaking, five systems available for heavy electric traction:

(1) The direct current system, such as now exists on our street and interurban lines.

(2) The alternating-direct current system, consisting of substations placed at intervals along the line to which alternating current power is transmitted at a high voltage and then lowered by step-down transformers to synchronous motors driving direct current generators feeding the trolley.

*Paper read before the Canadian Railway Club, Montreal.

(3) The single phase alternating current system, in which single phase motors receive power from transformer sub-stations along the line which receive either high voltage single-phase or polyphase alternating current from the power station.

(4) The Leonard system, in which direct current motors are fed from motor-generators on the locomotives, the latter receiving single phase alternating current from the power station, either direct or through transformer sub-stations along the line.

(5) Polyphase system, in which three phase alternating current induction motors on the locomotive are fed from three phase transformer sub-stations along the line, which receive three phase alternating current from the power station.

Diagram herewith shows the different features of the various systems.

The advantages, disadvantages, and limitations of the various systems are as follows:

(1) Direct Current. Propulsion by direct current distribution direct is limited to short distances on account of the low limiting pressure of 600 volts, which makes the cost of copper prohibitive for heavy traction over average distances. Other things being equal, the weight of the copper required is inversely as the square of the voltage. The collection of the large amounts of current required with a larger electric locomotive, frequently amounting to 2,000 H.P. at starting, becomes extremely difficult if not impossible with an overhead feeder in a 600 volt D.C. system, so that recourse has to be taken to the third rail. The objections to the latter are so numerous and are so well known that they do not need to be gone into detail, except to mention that the third rail is likely to cause accidents to section men, increase cost of maintenance, and in case of a slight derailment, its presence might result in serious damage and the blocking of the road for a considerable length of time. It is indeed true that the wrecked portion might be isolated, as regards danger, by cutting off the current; it would also, however, to a great extent, be isolated as regards ability to bring up other apparatus for clearing the track. In fact, if the presence of a third and probably a four thrail were a necessity in connection with the introduction of electric traction, it is seriously to be doubted whether most of our railway companies would ever be brought to consider it. Other serious drawbacks, such as the comparatively large rheostatic losses occurring at the starting up of the motor, also the dangers from electrolysis, might be mentioned showing the unsuitableness of this system for heavy traction.

(2) Alternating Direct Current. In this method of distribution, the losses in transmission and the expenditure for copper are avoided by distributing alternating current at a high voltage to sub-stations placed at convenient distances, in which are installed step-down transformers and rotary converters which convert the alternating current of lowered pressures to 600 volts direct current feeding into the trolley of third rail.

This is the system adopted by the New York Central, and is the one installed by the Lancashire and Yorkshire Railway on their double tracked twenty-three mile line between Liverpool and Southport.

Alternating current three phase power is generated for this road at 7,500 volts, of a frequency of 25 cycles, and is transmitted from a power house to four sub-stations, which step-down the high tension current to low tension alternating current, from which it is converted in rotary converters to direct current, a 600 volts. This power is fed thence through feeder conductors, to the third rail, and returned from fourth rail bonded to each running rail by return feeders.

The drawbacks to the previous system apply equally to the direct current part of this system, and in addition there are the disatvantages of the sub-stations containing the direct current rotary converters, which being revolving machines require manual attendance, entailing a large initial expenditure, and a large operating staff as well as increasing liability to break down, by the introduction of another link in the electric circuit.

In view of the various disadvantages, as mentioned in the foregoing, it might be interesting to look into the reasons for the adoption by the New York Cent. Ry. of this system. The reasons for their action, it would appear, were those of policy, as well as engineering. The word policy in this respect refers to the idea that the system adopted should leave opportunity for he possible future interchange of equipment with other local systems, including the Rapid Transit lines. The relative costs of the A.C. and D.C. systems were in favor of the direct current equipment, and a further objection to the A.C system was the use of an overhead construction of bare wire in tunnels and viaducts, which included liability of injury to trainmen as well as a tendency to corrosion of wires from the gases of freight steam locomotives. Among other points, was the fact that the A.C. locomotive would have a greater weight, thus adding 7 to 10% to the train weight, with a consequent increased cost of transtmission, installation, and operation of power plants. Further, the cost of maintenance of alternating current apparatus would be greater. The depreciation would also be greater, due to the equipment being more novel, and more or less untried, and would, therefore, have to be discarded in the near future to make room for improved types, whereas the direct current apparatus, being standardized, and universally in application, would prove a good asset.

(3) The Single Phase system to-day is, in the opinion of the majority of engineers, the one which is essential for heavy and long distance railway service, and conforms to the ideal requirements for electric traction. The development of the system has only become prominent and made possible within the last two years, due to the fundamental feature of the system, the single phase commntator motor, having been brought to a high degree of perfection for railway work. It should be borne in mind that the advantages accruing from this system are due primarily to the use of alternating current, rather than to any advantages of the A.C. railway motor over the D.C. railway motor, though it should be noted that it has equally good characteristics, and is almost as efficient.

The credit of the many advantages gained with this system, however, must be given to the A. C. railway motor since its development has made the exclusive use of single phase alternating current on railway systems practicable.

The details of one of the several single phase roads now operating are as follows: Power is generated at 2,200 volts, and in the power house, by means of static transformers having no moving parts, transformed to 33,000 volts. At this voltage it is transmitted to transformer stations, located every ten or twelve miles along the line, where it is reduced to 3,300 volts and fed to the trolley. The transformer stations require no attendants, as the feeder lines are all controlled from the power house, and the stations have no apparatus with moving parts. The 3,300 volt trolley current is carried into the car by a bow trolley, and through a static transformer, in the car, reduced to 250 volts for which the motors are designed. This is an extremely flexible system; by making changes in the transformers, which are not expensive and always good assets, the transmission voltage or the trolley voltage can at any time be changed to meet the requirements of new conditions which may arise. The trolley voltage could be increased to 6,000 volts, which would give sufficient power for operating one-hundred-ton locomotives, with the same size trolley wire in use. In order to protect passengers and crew from the high pressure used in this system, all car wiring is placed in metal conduits and connected to trucks, so that should any defect in insulation develop it will result in the tripping of the automatic circuit breaker in car or locomotive.

With the single phase A.C. system, the overhead conductor and its many advantages are retained. There are objectionable features to its use, some of which may be named as follows: (a) Difficulty of securing head room through tunnels under bridges as existing structures. These have been eliminated by using a third rail. (b) Snow and ice will collect on the trolley wire. This has been overcome, with more or less success, by coating wire with various solutions or greasing it, by supporting wire from underneath, and collecting current from top of wire, as is done in several Swiss installations, or by passing a heavy low voltage current through wire, raising temperature of same. (c) Poles and guy wires breaking, and allowing the trolley wire to fall, or breakage of trolley wires. These latter objections are possible to avoid by better construction, which has been introduced with the single phase railway, and consists of a catenary suspension cable or cables supported on insulators on suitable brackets from poles, trolley wire being suspended at intervals of ten to twelve feet from steel cables; this method of suspension allowing of trolley wire being kept at a uniform height above the tracks. For heavier service steel bridges spanning tracks, and carrying the suspension cables, may be used. Liability of a break occurring is reduced to a minimum by using two cables.

A summary of the principal advantages of the A. C. lectric traction over the D. C. are:

(1) Limits to trolley voltage are removed.

(2) Avoiding of rheostatic losses.

(3) No necessity for rotary converter sub-stations with manual attendance.

(4) Danger of electrolysis by return current avoided.

These and other advantages are so well recognized by engineers that this form of electric traction is now being taken up in England, Europe and South Africa, as well as on this continent. The Swedish Government railways have purchased equipment, and are making experiments with trolley voltages up to 18,000 volts, and eliminating the use of sub-stations with step-down transformers, for lowering transmission voltage to a lower trolley voltage. In South Africa the Government has recently placed an order for the equipment of one of their main lines with this system.

In order to consider more in detail the relative costs of the alternating and direct current systems, I give herewith a comparative list of costs entering into the equipment of a sixty mile interurban road where the schedule proposed requires five local cars having one hour headway; one express car making the round trip in three hours and one freight car making trip between terminals in eight hours.

ESTIMATED COST OF THE ELECTRICAL EQUIPMENT OF A 60-MILE SINGLE TRACK INTERURBAN RAILWAY.

POWER-HOUSE.	Direct Current System.	Alternating Current System.
Building	$10,000	$10,000
Foundations	2,500	2,500
Boilers and settings	12,000	12,000
Steam piping and covering	7,500	7,500
Engines	22,000	22,000
Generators	18,000	23,000
Exciters	1,000	1,000
Step-up transformers, 800-kw	8,000	7,500
Switchboard	3,500	3,000
Wiring	3,000	2,500
Feed-water heater	800	800
Pumps	800	800
Coal storage	1,000	1,000
Smoke-stack and flues	2,000	2,000
Fuel economizers	3,000	3,000
Stokers	3,500	3,500
Incidentals	4,400	4,400
Total	$103,000	$106,500

SUB-STATION IN POWER HOUSE.	Current Direct	Alternating Current
Building extensions	$ 1,000	$ 600
Synchronous converter, 300-k.w.	4,800	
Transformer, 300-k.w.; 200-k.w. alternating current	3,200	2,000
Switchboard	2,000	1,300
Wiring	1,000	500
Incidentals	600	200
Total	$12,600	$ 4,600

48-MILE TRANSMISSION LINE.	Direct Current	Alternating Current
Poles charged on trolley line		
Copper	$10,000	$11,500
Insulators, pins and cross-arms	7,500	5,000
Erection	4,000	3,000
Incidentals	1,000	1,000
Total	$22,000	$20,500

SUB-STATION ALONG THE ROAD	Direct Current	Alternating Current
Building	$2,000	$1,000
Synchronous converter	4,800	
Step-down transformers	3,200	2,000
Switchboard	2,000	1,300
Wiring	1,000	500
Incidentals	500	200
Total	$13,500	$5,000
Four sub-stations	$54,000	$20,000

TROLLEY-LINE AND FEEDERS	Direct Current System.	Alternating Current System.
Poles, 3,500	$17,500	$17,500
Poles distributed and set	4,000	4,000
Guys and anchors	2,000	2,000
Brackets with hangers	18,000	18,000
Copper, direct current:		
Feeder 12 miles, 500,000 cir. mils		
" 48 " No. 0000		
Trolley, 120 " No. 000	95,000	
Alternating current:		
Trolley, 60 miles, No. 00		21,500
Feeder insulators	2,000	
Erection	10,000	4,000
Incidentals	7,500	4,000
Total	$156,000	$78,000

BONDING OF RAILS	Direct-Current.	Alternating Current.
Both rails bonbed	$30,000	
One rail bonded		$15,000
Cross bonds	2,000	1,000
Total	$32,000	$16,000

ROLLING STOCK	Direct Current	Alternating Current
Ten vestibuled passenger-cars, each equipped with 4 motors, and weighing about 30 tons	$75,000	$ 85,000
Two express passenger-cars, each equipped with 4 motors, and weighing about 35 tons	18,000	20,500
Two freight-cars, each equipped with 4 motors, and weighing about 30 tons	10,000	12,000
Snow-plough and construction car	7,000	8,500
Total	$110,000	$126,000

RECAPITULATION.	Direct Current.	Alternating Current.
Power House	$103,000	$106,000
Sub-station in power house	12,600	4,600
Transmission line	22,500	20,500
Sub-stations	54,000	20,000
Trolley line and feeders	156,000	78,000
Bonding	32,000	16,000
Rolling stock	110,000	126,000
Total	$490,100	$371,600

Cost per mile, direct-current system..... $490,100/60 = $8,168
" alternating-current system. 371,600/60 = 6,193

Saving per mile, alternating-current system $1,955

The decrease of alternating-current cost in terms of direct-current investment, 25%.

The increase of direct-current cost in terms of alternating-current investment, 32%.

(4) The Leonard System is in reality a form of foregoing system, and involves the supply of single-phase current to an alternating current motor on the locomotive, motor in turn driving a direct current generator. This generator furnishes current for the operation of the car motors. By varying the voltage of D. C. generator by means of rheostat, any desired voltage may be obtained on motor supply circuit, thus allowing of the obtaining of a perfectly smooth and rapid acceleration, with minimum energy, from the supply circuit, and the starting up of a locomotive does not produce a peak in the load diagram. Such a system, while it may be feasible in the case of large locomotives, yet does not furnish a general solution of the railway problem, as the arrangement is not flexible enough. In the ideal system the same method of operation, and the same types of apparatus, should be used on the feeders or branch lines as on the main lines, if full benefit is to be obtained by electrification.

(5) The Polyphase system has been developed by European engineers, and a number of installations have been made in Europe. American engineers consistently refuse to adopt the polyphase induction motor for the following reasons, namely: (a) The motor is inherently a constant speed one, and therefore not adapted for traction work; at one definite speed only is the

polyphase motor efficient. One expedient used to overcome this is to run motors in concatenation or tandem, which gives a second speed at one-half of normal speed. By winding motors for a different number of poles, more than the two speeds may be obtained, but this arrangement has the disadvantage of being able to use but one-half of the total motor capacity above half speed, while the greatest expenditure of energy takes place above that speed. (b) The necessity of providing for at least two overhead conductors. (c) The fact that motors must be built with small air gaps to give most efficient results.

The advantages of the polyphase motor for traction purposes are as follows:

In contrast to the single phase motor, the tractive effort at starting is greater. This is due to the fact that in the single phase motor the torque is not constant, but varies between a maximum and zero, with double the frequency of the line current. The mean value of the torque is only one-half of the maximum torque when slipping wheels, which means, where the tractive effort required necessitates going to the limit of adhesion between wheels and track, a single phase locomotive must have almost twice as much weight on drivers as either a D. C. or three phase locomotive. This difference holds true only for motors mounted directly on car axles, and will be somewhat less if geared.

The weight of a three phase motor is only about three-quarters of the D.C. motor of equal capacity, and approximately one-half that of a single phase motor, and the cost is also less. The cost of equipment is also made lower, as the transformers on the locomotive may be dispensed with, as motors of this type are now made for operation direct on voltage up to 10,000 volts.

The three phase motor is probably the most robust and thoroughly mechanical piece of machinery extant, and the maintenance of same would be less than with any other system.

Generally speaking, the conditions most favorable for the adoption of this system are rare, and are when the lines are long when there are few trains with few stops, and when the lines have long and regular gradients, particularly if there is plenty of motive power and it is cheap. In the case of the mountain railways, the polyphase system has a special advantage in that power may be returned to the line when running down hill, motors acting as generators and thus allowing of the electrical braking of trains.

While the wholesale retirement of the steam locomotive in favor of its electrical competitor cannot take place in the immediate future, owing to capital now invested, there are many isolated sections of steam roads in the operation of which electric traction could effect economies which would well pay for its adoption.

These economies may be in the direction of a reduced fuel, labor, and maintenance account, but may be more far reaching, and warrant changes in the present method of operating by steam. The millions of dollars contemplated for reducing grades, and double tracking certain sections of single track roads in order to increase their capacity with steam locomotives, might be spent with promise of a greater return if used for installing electrical equipment.

The whole situation as regards electric traction is excellently summed up in a few words spoken by Mr. George Westinghouse, during the opening exercises of the American Railway Appliance Exhibition held in Washington in connection with the International Railway Congress. He stated the case as follows:

"A new era in railway operation has dawned with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive, that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world, and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity.

"With these changes have come vastly different engineering problems and new sources of danger, which should and will command and receive that attention which is essential to the surmounting of every difficulty as it arises."

A by-law will be submitted to the ratepayers of Fort Frances, Ont., to provide funds for the installation of an electric light plant.

AMERICAN STREET RAILWAY ASSOCIATIONS.

The annual conventions of the American Street Railway Association, the American Railway Mechanical and Electrical Association, and the Street Railway Accountants' Association of America, were held at Philadelphia, Pa., during the week commencing Sept. 25th. Hon. W. Caryl Ely, president of the Street Railway Association, delivered a lengthy and interesting address, in which he explained the proposed plan for the reorganization of the association upon broader lines.

A large number of very interesting papers were read, including the following: "The Single Phase Railway System," by Charles F. Scott. The author stated that the single phase railway system decreases the cost of installation and operation for the kind of interurban service which has been successfully developed by the direct current, and it extends the field of commercial operation to include, on the one hand, rural roads with comparatively light traffic, and on the other, a heavy infrequent multiple unit for locomotive service for passenger or for freight approximating steam railway conditions. Mr. J. I. Bibbins, in a paper on "The Application of Gas Power to Electric Railway Service," discussed the adaptability of the gas engine and producer plant to meet the severe requirements. He presented a number of very interesting load curves. Mr. Arthur West read a paper on "Notes on the Design of Large Gas Engines with Special Reference to Railway Work." He stated that the thermal efficiency of the gas engine is about 25 per cent., though efficiencies well over 30 per cent. have been obtained. The large size gas engine had come to fill such an important place in Europe that there is no question about its being adopted on this Continent in the near future, in a form suited to American operating conditions.

The American Street Railway Association will hereafter be known as the American Street and Interurban Railway Association. Mr. Ely was re-elected president.

Before the American Railway Mechanical and Electrical Association, Mr. C. H. Hile read a paper on "Power Distribution", in which he described the system of the Boston Elevated Railroad Company. "The Power Station Load Factor as a Factor in the Cost of Power" was the subject of a paper by Mr. L. P. Crecelius. He showed the advantage of interconnecting several stations by means of bus-bars and shutting down certain ones completely during periods of light loads. Two papers relating to controlling apparatus were presented as follows: "Multiple Unit System of Train Control," by Mr. Hugh Hazelton, and "Series Parallel Railway Controller", by Mr. W. A. Pearson.

SETTLERS LOW RATE WEST.

The Chicago and North Western Railway will sell low one way second class settlers tickets, daily from Sep. 15th to Oct. 31st, 1905, to points in Utah, Montana, Nevada, Idaho, Oregon, Washington, California and British Columbia. Rate from Toronto to Vancouver, Victoria, New Westminster, B. C., Seattle, Wash., or Portland, Ore., $42,25; to San Francisco or Los Angeles, Cal., $44.00. Correspondingly low rates. Best of Service. For full particulars and folders write to B. H. Bennett, General Agent, 2 East King St., Toronto, Ont.

W. K. Lowden, St. Lambert, Que., has recently purchased from the Robb Engineering Company, Amherst, N.S., two 100 h.p. boilers and one 150 h.p. engine for sewer pipe works.

Some advertisers make space yield a large income. Others can't make it yield what it cost them to buy it. It's what you put in it that makes the difference.—Rhode Island Advertiser.

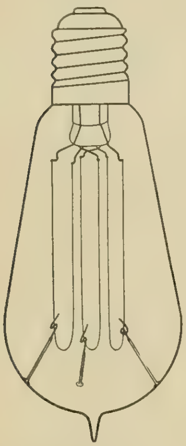
The Southern Light & Power Company have offered to supply electric light to the village of Weston, Ont., at $6 per 32 c.p. light per year, for an all-night service. This company are now lighting the village of Streetsville.

J. R. Booth, Ottawa, has recently purchased from Robb Engineering Company, Limited, Amherst, N.S., two 400 h.p. Robb-Armstrong Corliss engines, one 350 h.p. Robb-Armstrong Corliss engine and three 100 h.p. Robb-Armstrong Corliss engines. This machinery is for Mr. Booth's new paper mills.

The Town of Napanee, Ont., have recently purchased from Robb Engineering Company, Amherst, N. S., two 200 h. p. Robb-Armstrong Corliss engines, two 120 h.p. return tubular boilers, and one 200 h.p. "Robb" feed water heater. This machinery is for their new municipal lighting plant.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

The Osmium Lamp.—The Osmium lamp, which is the invention of Dr. Carl Ritter Auer von Welsbach, the inventor also of the incandescent gas mantel known in this country under the name of Welsbach mantel, and on the Continent under the name of the Auer mantel, is on the market of Great Britain and Germany. The illustration shows a 50-volt, 25-c.p. lamp, guaranteed at 1.5 watts per c.p. The filament, which has an approximate length of 15 in., is divided into three separate loops which are connected in series by means of two loops of platinum wire, the middle of each of which is fused by means of a glass head to the top of the stem carrying the two leading-in wires. Each filament is anchored in order to prevent the loops from touching. The anchoring device consists of a small glass rod, to the end of which is attached a turn of small wire of white refractory material, as shown in the illustration. Formerly these anchor terminals were made of metal, but as it was found that the filament always parted at this point the refractory material was substituted. It will be seen that the filament is anchored, not at its extremity, but somewhat above the turn of the loop. The lamps can be burned only in a vertical position. During the first 200 hours of burning, or thereabouts, there is a slight increase of candle-power due to particles of osmium being fused together by the current passing through the filament. At the end of this period the candle power reaches a maximum and decreases afterward. It was at one time stated that the actual life of the filaments might be as high as 5,000 hours, but that the useful life is only 2,000 hours, by useful life being understood the time during which the candle-power maintains 80 per cent. of its initial value. The English company, however, guarantee a life of only 500 hours at a consumption of 1.5 watts per candle.

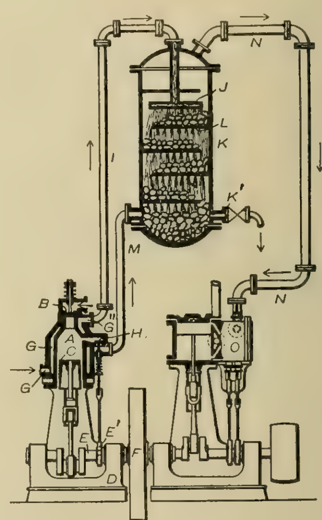


THE OSMIUM LAMP.

An Interchangeable Transformer.—The Wagner Electric Manufacturing Company, of St. Louis, are now placing upon the market types M. and M. H. oil filled interchangeable transformers for both lighting and motor service. These transformers embody literally two in one. The three important claims made for them are as follows:—First: The same regulation on unbalanced three-wire load as on two-wire load. Second: Satisfactory regulation on lighting and motor load in combination. Third: A complete interchangeability for lighting and motor service, without the introduction of special taps for changing ratios.

500 H. P. Diesel Engine.—At the International Exhibition at Liege, Belgium, there was exhibited a 500 h. p. Diesel engine built by the Societe Anonyme des Ateliers Carels Freres, of Ghent. It is intended to operate at 150 r. p. m., and is direct coupled to a Lahmeyer generator. The engine has three cylinders, the three cranks being placed at an angle of 120° from each other. Forced lubrication is used for the piston and piston rod, and automatic ring lubrication for the bearings. The temperature of the cooling water is kept at about 70° C.; as is usual with this type of engine, compressed air is used for starting, only two of the cylinders being used for this purpose. The fuel consumption is most economical, crude Texas oil of specific gravity 0.925-0.930 being used. This is the largest Diesel engine yet built.

Combination Gas and Steam Engine.—For the utilization of the energy contained in the exhaust gases of internal combustion engines, The Engineer says that the invention shown in the accompanying cut was patented by Arkadius Houkowsky. In the apparatus shown, *A* is the high-pressure cylinder with a



COMBINATION GAS AND STEAM ENGINE.

valve *B* for the admission of the explosive mixture. *C* is the high-pressure piston connected with a crank *D* on the main shaft *E*, which also carries the flywheel *F*. *G* is the water jacket on the high-pressure cylinder, having an inlet at G^1 and an outlet at G^2, and *H* is the exhaust-valve of the high-pressure cylinder, this valve being controlled by an eccentric E_1 on the main shaft. From the cooling jacket the water passes through a pipe *I* to a sprayhead *J*, located within a casing *K*. This casing also contains a series of shelves *L*, arranged in baffle-board fashion and supporting loose material of large surface, such as pieces of coke. The water from the sprayhead *J* travels downward over the shelves and the material thereon and finally escapes at the bottom through an outlet K^1. From the high-pressure cylinder the exhaust gases pass through a pipe *M* to the bottom of the casing *K* and then travels upward in the casing. The gases and the water are thus brought into intimate contact and are caused to exchange their heat, and by proper proportioning of the amounts of water and exhaust gases, a large portion of the water may be converted into steam. This steam together with the exhaust gases which have been purified by contact with this water, passes from the top of the casing *K* through a pipe *N* to the steamchest *O* of the low pressure cylinder *P*, adding in this way to the power of the engine.

TELEGRAPH and TELEPHONE

ORGANIZATION OF TELEPHONE COMPANIES.

A convention of representatives of independent telephone companies was held in Toronto last month, the meeting being called to order by Mayor Urquhart, of Toronto. Mr. A. F. Wilson, who was the moving spirit in the convention, was appointed secretary pro tem.

Among those present were the following: Alph Hoover, Green River (Markham and Pickering Co.); H. S. Milne, Brown's Corners (Scarboro Telephone Co.); Dr. W. Doan, C. B. Adams, W. J. Coates, Wm. Barr, Harrietsville (Harrietsville Telephone Association, Limited); A. R. Walsh, Orono, and S. S. Hallowell, Starkville (East Clarke Phone Line); John A. Sprague and J. S. Sprague, Demorestville (Sprague Co.); F. D. McKay, M. H. Ludwig, and S. B. Allan, Toronto (Canadian Machine Telephone Co).; Geo. Nealy, Dorchester, A. D. Bruce, Gormly (Bethesda and Stouffville Co).; F. Dagger, Ottawa; R. Y. Ellis, Toronto; D. J. Johnston, Chicago (Lorimer Automatic Telephone Co.); M. McPherson, C. Heinz, Brantford (American Machine Telephone Co).; J. Gibson, Rochester (Stromberg Carlson Telephone Mf'g. Co.); Alex. Neilson, Brown's Corners (Scarboro Telephone Co.); M. H. Oversolt, Jordan (Lincoln Telephone Co.)

Mayor Urquhart referred to the recent enquiry at Ottawa into telephone matters, which had brought to the attention of the public the large number of independent companies doing business with profit to their subscribers. He thought the future would bring about the ideal state of Government ownership of trunk lines and municipal management of local branches.

The report of the committee on resolutions urged up on the Dominion Government the consideration of the nationalization of the long-distance lines, and the giving of access thereto to all telephone organizations doing business in Canada. The Government was also requested to pass such legislation as would prevent any exclusive contracts between telephone and transportation companies, and compel the latter to give access to their premises to all telephones, no charge for installing a 'phone in any station being permitted. Municipalities and independent companies were warned against making special agreements with or giving exclusive franchises to any company before the final report of the special Parliamentary Committee is made on the question. The Dominion Parliament was congratulated on the active interest its members had taken in telephone matters, and it was hoped the enquiry would be continued next session.

It was decided that the official name of the association should be the Canadian Independent Telephone Association, with headquarters at Toronto. The membership was confined to representatives of municipalities and shareholders in independent companies, two members only from each being allowed to vote at meetings. The offices to be filled were president, vice-president, secretary-treasurer, and an Executive Committee of nine members.

The following officers were elected: President, A. Hoover, Green River; vice-president, F. D. McKay, Peterboro; secretary, A. F. Wilson, Markham; executive committee, Dr. Demers, Quebec; Dr. Doan, J. A. Sprague, Demorestville; T. A. E. Esterbrook, St. John, N.B.; Dr. Oches, Hespeler; Mayor Vickers, Port Arthur; Dr. Hart, Brantford; Levi Moyre, Beamsville, and C. J. Thornton, Kerby.

A HYDRAULIC LONG DISTANCE TELEPHONE.

Prof. Quirino Maiorana, an Italian scientist, has been engaged for some time in perfecting a hydraulic telephone, and has succeeded in transmitting speech distinctly from Rome to London. The successful results of this experiment have been confirmed recently, when the London General Post Office was able to understand clearly whatever conversation was transmitted from Rome. The success of this experiment is the more remarkable as the telephone line, Rome-Parish-London, apart from its lengths, includes submarine cables in the channel, so that this achievement can be said to be the most important telephone transmission ever obtained up to now.

SHORT CIRCUITS.

The ratepayers of Dauphin, Man., have voted in favor of a municipal telephone system.

The Miramichi Telephone Company, Chatham, N.B., have sold out to the Central Telephone Company.

The Hinton Electric Company, of Vancouver, B.C., have just completed a telephone system for Vernon and vicinity, carrying 125 telephones.

The ratepayers of Port Arthur, Ont., will vote on a by-law on October 16th to raise $18,000 for erection of a telephone building and extension of the system.

The Bell Telephone Company have recently completed a copper metallic line from Doucet's Landing to Nicolet, Que. This forms a direct circuit from Montreal to Three Rivers.

The Bell Telephone Company have been given a renewal of their franchise at St. Catharines, Ont., for five years. Free telephones will be installed to the amount of $475.50 and a $400 cash bonus given.

Messrs. L. E. Carson, electrical engineer of the American Telephone Company, and S. P. Young, superintendent of construction, are making a survey for a direct telephone line between Kingston, Ont., and Watertown, N.Y. At present the telephone connection between these two places is secured in a roundabout way by Ogdensburg.

The Central Telephone Company, recently granted a charter by the New Brunswick Government, is destined to become an important factor in the telephone business of the province. They have already acquired the local system at Chatham, Richibucto, Bathurst and Campbellton. The intention of the promoters is to have a trunk line with which the various exchanges will be connected, and extensions will be made to secure connection with Montreal.

The Okanagan Telephone Company have had a complete telephone system installed in Vernon, B.C. The Hinton Electric Company, of Victoria, had the work in hand, the installation being done under the direct supervision of their Mr. Robert Jamieson. The system will cover the business section of the city and include a great many of the residences. A 100 drop switchboard is in use and everything in the central station is arranged to provide for expansion.

Mr. B. S. Jenkins, general superintendent of C.P.R. telegraph lines in the West, states that his department are getting ready to protect the company's interest between Winnipeg and Fort William wherever blasting operations are going on in connection with the double tracking of the road. Many miles of cable will be necessary and the present poles and wires will be taken down. Work that might not interfere with the passage of trains would paralyze the telegraph. Good progress has been made in stringing the new copper wire from Winnipeg to the Coast. Some delay was caused by an iron wire ordered from Germany becoming damaged by soft water while crossing the Atlantic, making it necessary to re-order.

WESTINGHOUSE PREPAYMENT WATTMETERS.

Most consumers of electrical energy prefer metered service to the payment of flat rates, but there are always a large number who are not prompt in the payment of bills and who cause much trouble for the collection department. In many cases these customers are not financially responsible, and in the course of a year the loss to the operating company amounts to a considerable sum. With metered service it is impossible to arrange for payment in advance, and the problem of insuring protection to the company furnishing energy was unsolved until the advent of the prepayment integrating wattmeter. Not only will this meter insure the lighting company against the nonpayment for energy used, but offers advantages to the consumer as well. There is no possibility of error in bills due to carelessness in taking meter readings, and the resulting complaints from consumers are eliminated. Customers are also relieved of the trouble and time necessary to go to the office to pay bills, or the annoyance of a collector, and the expense of his services to the lighting company are dispensed with.

The prepayment meter has great usefulness in such fields as sign lighting and window illumination for stores. By inserting the proper number of coins the sign, display window, arc lamp or other device may be automatically extinguished at a predetermined hour, thus obviating the necessity of a watchman's services to perform this duty, or placing time switches. In this manner a separate account of the display may also be kept. In automobile garages prepayment wattmeters may be used to great advantage with Cooper-Hewitt charging outfits and motor-generator sets.

The Westinghouse prepayment integrating wattmeter is similar in mechanical and electrical details, with the addition of the prepayment feature, to the operating mechanism of the Westinghouse type B watt-meter. The addition consists essentially of a circular dial and pointer, a coin slot and a circuit closing mechanism. When a coin is inserted in the slot it strikes a wheel, releasing a spring which closes the circuit through the electro magnet of a switch connected to the main circuit. The appearance of both the two and three-wire single phase meters is shown in Fig. 1.

FIG. 1.—SINGLE PHASE PREPAYMENT WATTMETER.

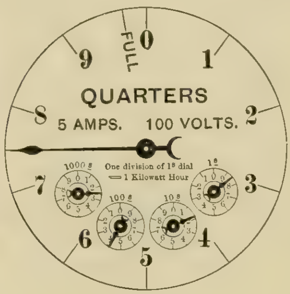


FIG. 2.—DIAL.

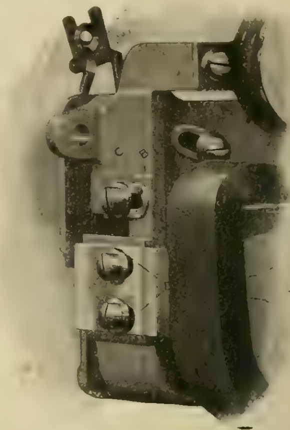


FIG. 3.—ADJUSTMENTS.

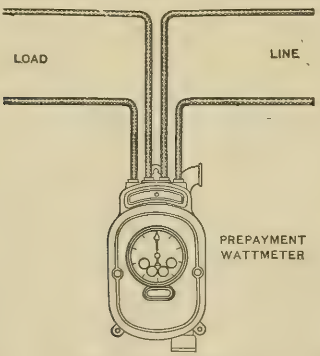


FIG. 4.—TWO WIRE PREPAYMENT WATTMETER.

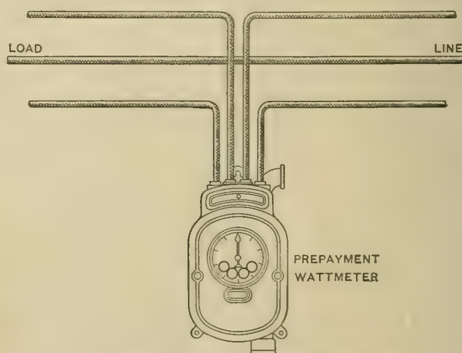


FIG. 5.—THREE WIRE PREPAYMENT WATTMETER.

DIAGRAM SHOWING CONNECTIONS TO CIRCUIT.

The coin dial is plainly marked in ten divisions, each division representing a quarter of a dollar, that being the size of coin for which the meter is designed. One or more quarters up to ten may be inserted at one time, the amount of current paid for being indicated by the position of the pointer. In Fig. 2 the pointer stands between 7 and 8, and if a quarter were dropped in, the large pointer would at once assume a corresponding position between 8 and 9. The pointer is so connected with the train of gears that records the consumption, as indicated on the four smaller dials, that as the

current is consumed the large pointer travels backward until the amount paid for is entirely used and the pointer reaches zero, when the current is automatically cut off. In the dial shown the consumer has nearly seven and one-half quarters to his credit, or about $1.88. An ingenious arrangement is provided whereby any coin smaller than a quarter will pass through the slot without operating the mechanism. The coin receptacle will hold a total of forty quarters. The meter can be adjusted for any rate met with in common practice, that is, from 10c. to 25c. per kilowatt-hour, varying by increments of one cent. The meters as shipped are arranged for a definite rate which the customer himself may change by ordering a new shaft on which the first counter is mounted. The kw. capacity or current and voltage marking of the meter and the rate per kw. hour must be given when ordering rate changing parts. The shaft can readily be taken out by removing an adjustable bracket from the back of the dial mechanism. The covers of all meters are sealed to guard against being tampered with.

The adjustments of the Westinghouse prepayment meters are shown in Fig. 3. Moving the magnets in from the edge of the disc will increase the speed and moving them out will decrease it at any given load. By loosening the screws at D the magnets may be moved as required. Compensation for friction may be made by means of the screw at A. Meters which are calibrated for circuits of 16,000 alternations per minute are so arranged that they may be changed to operate on 7200 alternations by moving the slide C.

Westinghouse prepayment wattmeters may be obtained for either two or three-wire single-phase circuits. The two-wire instruments are manufactured in six styles for 50 or 100 volts—5, 10 or 20 amperes; the three-wire instruments in three styles, for 100 volts—5, 10 ar 20 ampers. The counters in both two and three-wire instruments record the exact amount of energy supplied to the circuit, and no multiplier or constant is necessary.

MOONLIGHT SCHEDULE FOR NOVEMBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Nov. 1	5 20	Nov. 2	6 00	12 40
2	5 20	3	6 00	12 40
3	5 20	4	6 00	12 40
4	10 40	5	6 00	7 20
5	11 40	6	6 00	6 20
7	0 40	7	6 00	5 20
8	1 30	8	6 00	4 30
9	2 30	9	6 00	3 30
10	3 30	10	6 00	2 30
11	No Light	11	No Light	
12	" "	12	" "	
13	5 10	13	7 40	2 30
14	5 10	14	8 20	3 10
15	5 10	15	9 10	4 00
16	5 10	16	10 00	4 50
17	5 00	17	10 50	5 50
18	5 00	18	11 50	6 50
19	5 00	20	1 00	8 00
20	5 00	21	2 00	9 00
21	5 00	22	3 10	10 10
22	5 00	23	4 20	11 20
23	5 00	24	5 30	12 30
24	5 00	25	6 20	13 20
25	5 00	26	6 20	13 20
26	5 00	27	6 20	13 20
27	5 00	28	6 30	13 30
28	5 00	29	6 30	13 30
29	5 00	30	6 30	13 30
30	5 00	Dec. 1	6 30	13 30
			Total............	230 40

MR. W. A. SWEET.

Mr. W. A. Sweet, of Hamilton, chief engineer and station superintendent for the Hamilton Cataract Power, Light and Traction Company, whose portrait appears on this page, was elected president of the Executive Council of Canadian Association of Stationary Engineers at the convention held in Chatham on August last. Mr. Sweet first served his apprenticeship as a miller in the Woodburn Mills, during which time part of his duties were to look after the engine and boiler. The engine was one of the old Beam type. After serving four years in this position he entered the engine shops, but four years later returned to stationary engineering. He operated some of the best plants in and around the city of Hamilton, his engineering ability having placed him in the ranks of the best engineers in the Dominion.

The stations of which Mr. Sweet is now superintendent are four in number, the principal one being located on Victoria avenue and having an auxiliary steam plant of 3,000 h.p.; transformer capacity of 12,000 k.w.; storage battery plant of 264 cells or 410 k.w.

MR. W. A. SWEET, Hamilton,
President of the Canadian Association of Stationary Engineers.

hours; two railway motor generator sets of 1,000 k.w. each; and one motor generator for direct current service of 375 k.w., also alternating power service and incandescent and alternating arc lighting services.

In sub-station B, which is located in the east end of the city, there is transformer capacity of 12,000 k.w., which supplies the eastern portion of the city with power and light. This station has one 275 k.w. motor generator set for supplying power to railways, while at Burlington Beach there is a 500 h.p. steam driven railway generating plant. Mr. Sweet has also under his supervision the company's steam heating plant for the offices, warehouse and store-rooms. From this plant is also heated the large stone hotel known as the "Victoria," which is adjoining the company's property.

The Canadian General Electric Company have acquired additional property at Peterboro for the purpose of extending their works. It is understood that upwards of $300,000 will be expended in making additions to the wiring and lamp building, machine shop, brass foundry, transformer building and blacksmith shop. A new building will also be provided for the manufacture of Curtis steam turbines.

GOLDIE & McCULLOCH CORLISS ENGINES.

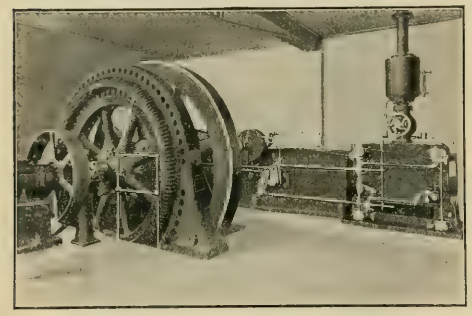
The Goldie & McCulloch Company, Limited, of Galt, have recently entered into the manufacture of Corliss engines, and the following description is of their standard heavy duty engine, which has been designed particularly for direct connected electrical work, having in view the peculiar difficulties which this work presents.

The frame is of very plain but pleasing appearance, being of the box pattern with all ribbing inside. As it is cast in one piece and supported for its full length on the foundation, there is no possibility of its springing under severe strains of great and sudden changes of load. The bearings are babbitted and are of the four part type with wedge adjustment on both sides. The outside of the shells are turned and the frame casting bored to suit. This permits of an easy removal of the bottom shell by raising the shaft about one-eighth of an inch and rotating the shell around the shaft. The crank pit has a cast iron bottom forming a reservoir into which the waste oil from all parts of the engine can be conducted and drained off.

Out board bearing is ring oiling and babbitted. It rests on heavy cast iron wedges, which in turn are supported by a massive base which reaches to the same level as the bottom of the engine frame. The wedges permit of a vertical adjustment of the whole outer pillow block, while heavy set screws are provided to take care of a certain amount of horizontal movement.

The shaft is of open-hearth forged steel, with large fillets where there is a change of diameter.

The cranks are of the counterbalanced disc type, and are



GOLDIE & McCULLOCH CORLISS ENGINE.

made of semi steel. The pin is of large size and of open-hearth steel, ground into the crank to a taper fit, shrunk in and secured by a thin nut at the back. The pin is case-hardened and ground to a perfectly true surface.

The connecting rod is of solid end type with adjusting wedges which enter the side of the rod and are so placed that in taking up the wear the length from centre to centre remains constant. This arrangement of wedges renders them easily accessible, especially at the crosshead end ; it secures greater strength at the ends from the fact that nothing is cut from the section of the rod as with a vertical wedge, and gives a wedge which has a bearing the full width of the box. The whole rod is strong, simple and convenient.

Crosshead is made of semi-steel of the box pattern and fitted with babbitted shoes, which are adjustable by wedge and screws. The shoes are turned to fit the guides which are bored circular and central, with the piston rod allowing of perfect alignment. The pin is open-hearth steel with a taper fit in the crosshead, and is case-hardened and ground to a true surface. The piston rod is screwed into the crosshead and secured by a heavy nut. The shoe is held from moving lengthwise on the crosshead by an end plate, which maintains the pin in a central position with regard to the shoe at all times. By taking off this end plate the shoe can be removed without disturbing the crosshead.

Cylinder is cast of hard, close-grained iron. The end next the frame is cast closed. This prevents the necessity of having a steam joint next the frame. The advantage of this is apparent, for, in event of such a joint leaking, it would be necessary to remove the entire cylinder to render it again tight. The exhaust passage is separated from the c linder barrel by a dead air space, avoiding loss of heat by transfer due to the differences of temperature of the steam in the cylinder and the exhaust. The valves are double ported, insuring ample port opening with small angular travel and consequent minimum of wear. The valve seats are first rough bored, then reamed out with a spiral reamer, and finally lapped out to gauge and a perfect surface. The valves are ground to gauge. This gives a steam-tight contact between valve and seat at the outset and it is not necessary to run the engine some time before the leak past the steam valve disappears. The edges of the valves are milled straight, and the edges of the cylinder ports are planed by a special device, eliminating any chance of wire drawing of steam by reason of the valve and port edges not lining. The steam valves are relieved at the back, permitting them to rise from their seats in event of an accumulation of water in the cylinder, thus allowing it to escape. The steam pressure on all the valves is normal to the seat, which allows the valves to automatically take up the wear and remain tight indefinitely.

Radiation of heat is prevented by a coat of non-conducting material over which is placed a lagging of sheet steel. A heavy cast iron base plate, with raised edges, is placed under the cylinder, allowing all drips from the cylinder and valve gear to be collected and drained off. The dash pots, which are of the vacuum type, are fastened to this base plate.

Combination, relief, drain and indicator cocks are placed at each end of the cylinder.

The piston is of the box type, and is made with a broad junk ring, which is the full width of the piston. This carries a single packing ring of self-adjusting type.

The valve gear is operated by two eccentrics—one operating the steam valves and one the exhaust valves. The chief advantage of this arrangement is that the governor maintains control of the cut-off up to three-quarters stroke, instead of losing the control before half stroke, as is done with a single eccentric engine. An additional advantage is that the exhaust valves can be adjusted to open and close the exhaust at exactly the proper time. The steam valves are driven direct from the eccentric without a wrist plate. The exhaust valves are driven through a combination of short links and cranks, which gives the same effect as a wrist plate. As this whole motion is supported on the bonnet itself, there is no toggle strain tending to push the bonnet sideways, as there is with a wrist plate. The wearing surfaces are large, and the hardened steel latch plates have eight wearing surfaces, and are provided with a means for adjusting the amount by which one plate laps the other when hooked in. The valve stem lever is keyed to the spindle and is also split on one side and clamped, thus making it impossible for it to become loose. The lever is placed inside the bonnet, which brings it close to the valve and correspondingly reduces the effect of twisting action on the spindle. The device for unhooking the motion from the eccentric rod in order to operate the valve gear by hand is very simple. By rotating the small handle half a revolution, the reach rod is permitted to block.

The dash pots on engines running up to 120 revolutions are of the vacum type. Above this speed they are steam actuated.

The governor is the "Rites" Inertia Governor, and is fully covered by patents. The particular features of this governor are its quickness and sensitiveness due to the use of inertia, coupled with small friction and strain of work of tripping the valve gear. While the degree of regulation is much superior to the ordinary type of governor the steadiness is a feature, there being no tendency whatever to "race." For the parallel running of engine driven alternators of high frequency, this governor is particularly adapted.

T. W. Page, an Englishman employed by the Bell Telephone Company, Montreal, was killed by a live wire while making repairs to the line on Latour street. Upon reaching the top of a pole he is said to have come in contact with an unprotected wire, which hurled him to the ground below, a distance of 40 feet. Death was almost instantaneous.

The Canadian Westinghouse Company are supplying and installing all the necessary electrical apparatus for the new General Hospital at Vancouver, B.C. The equipment includes one 50 k. w. 125 volt compound wound direct current engine type generator, one 25 k. w. 125 volt compound-wound direct current engine type generator; one 11 x 12 direct connected Ideal engine, and one 9 x 10 direct connected Ideal engine, besides switchboards, etc. This plant will generate electricity sufficient for 1500, 16 candle power lamps.

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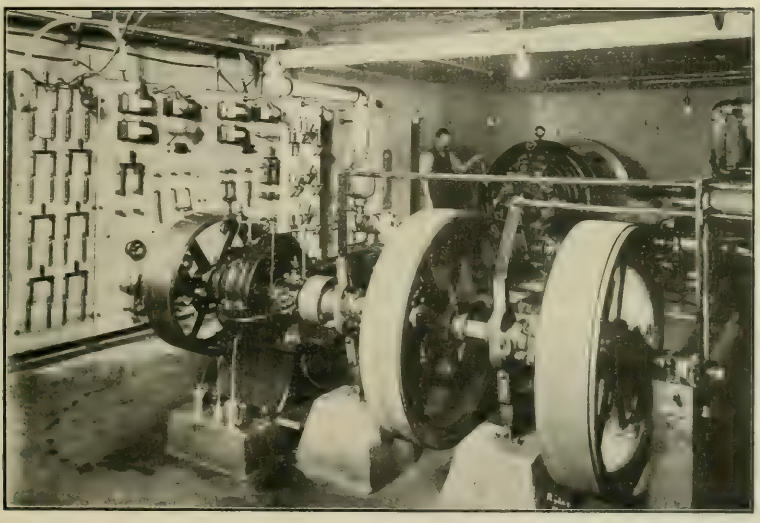
Power and Lighting Plant of the "Free Press" Building, Winnipeg

The new building of the Winnipeg Free Press is the largest in the Dominion of Canada devoted to newspaper publication. Security, convenience and beauty are the three considerations paramount in its construction. The massive pressed brick and stone exterior, strong as it appears, is but an outer shell, the building being structurally a steel cage, its columns and girders being completely enclosed in brick, terra cotta or other fire-resisting material. The floors throughout are of concrete, strengthened and braced by heavy steel netting buried in the material.

The power and lighting plant of the "Free Press" building consists of three units, as follows: One 120 h. p. Peerless engine, direct connected to a 75 k. w. Bullock generator supplying current for power purposes at 500 volts; one 80 h.p. Peerless engine, direct connected to a 50 k. w. Bullock generator supplying current for lighting circuits at 110 volts, and one 20 h.p. engine driving two belted machines, one of which generates current at a potential of 500 volts, the other at 110 volts. These small generators (14 k. w.) are driven by clutch pulleys mounted on the engine shaft and can be operated independently or together, as desired.

The "Free Press" publishing, as it does, both a morning and an evening edition, some part of the plant is in operation every hour of the twenty-four. Through the day the current required for lighting purposes is small and at certain hours of the night the power lines are also carrying a comparatively light load. This small unit was installed to relieve the large engines and generators of their light duties.



THE "FREE PRESS" PLANT—VIEW OF ENGINE ROOM, SHOWING 20 H. P. ENGINE. SHAFTING AND CLUTCH PULLEYS, ALSO 80 H. P. PEERLESS ENGINE DIRECT CONNECTED TO 50 K. W. BULLOCK GENERATOR, AND FOUR-PANEL SWITCHBOARD.

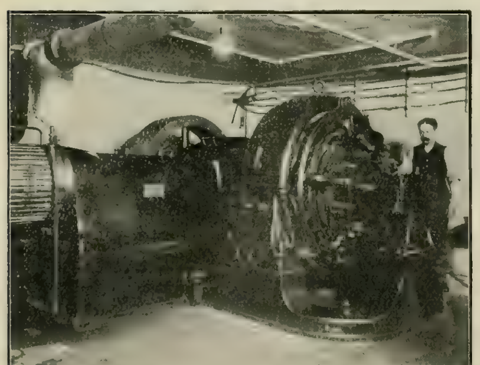
The steam generating plant comprises three tubular boilers each of 100 h. p.

It may be here stated that the individual motor system obtains in every department where electrical power is used. There are in all 33 motors, varying in capacity from ¼ h. p. driving each linotype machine, to 35 h. p. driving the Hoe Quad press. This large machine is operated by the Kohler system of speed control, a brief description of which may be of some interest. In this system two motors are used, one of 5 h. p. for starting the press and running at the slow speeds, the other of 35 h. p. for the higher speeds. A number of push button stations (8 in this particular instance) are attached to the frame of the press and so placed that a station will be within easy reach of the pressman at all times. Each of these

stations contains three push buttons as well as a safety switch.

The switchboard, which is of blue Virginia marble and upon which is mounted the various switches and devices for controlling and regulating the speed of the motors, is placed conveniently near the press. In starting, the attendant pushes the button marked "on". This closes the circuit in the coil located immediately back of the crosshead and releases the mechanism which supports it at its upper position. As the crosshead descends, the switch of the starting motor is automatically closed and the press starts. At each push of the button the crosshead descends a certain distance, the motor responding with an increase of speed. At the point where the small motor attains its highest speed the switch of the large motor automatically closes and the starting motor is relieved of the load. As the crosshead still further descends in response to the push of the button, the large motor gradually increases in speed until the small motor slows down until a point is reached about half way in the travel of the crosshead, when the small motor stops. As the crosshead nears the bottom of its stroke the resistance in the armature circuit is entirely cut out and the motor is running at its normal speed. Hurry up speeds are gained by allowing the crosshead to descend further, when it introduces resistance in the shunt field. The off button is used for reducing the speed or gradually slowing down preparatory to stopping. By pushing this button a circuit is established in the large coil which controls the crosshead and it ascends, restoring the resistance in the armature circuit and thus regulating the speed of the motor.

The stop button, as the name implies, is used when, through the breaking of the paper or from any other cause, it is necessary to stop the press at once. Pushing this button opens the circuit in the coil of the main switch, allowing it to drop, at the same time



The "Free Press" Plant- 120 H. P. Leonard Peerless Engine Direct Connected to 75 K. W. Bullock Generator.

completing a circuit through a resistance coil in series with the armature, which acts as a dynamic brake, bringing the machine speedily to rest.

The function of the safety switch in connection with the push button stations, is to provide every man working about the press with the means of protecting himself against accident, through the machine being inadvertently started while he is in a position in which he might be caught by the moving cylinders. The wiring of the station is so arranged that, when any of the safety switches are thrown, the circuit of the "on" button in each station is open and it is impossible to start the press.

The practical operation of the system is very satisfactory, affording as it does every facility for the complete control of the machine, and that too, at a number of different points, the pushing of a button

Push Button Controlling Apparatus for Hoe Quad Press.

being all that is necessary to effect any desired change in the running of the press.

The Webster system of heating is used throughout the building.

Careful provision is made to guard against a breakdown of the power and lighting plant. One huge boiler is always in reserve. A duplicate power and lighting plant is ready to start up at a moment's notice, and even in the event—a remote one—of the duplicate plant breaking down, a third is available in an instant through a conduit connection with the power and lighting plant of the Winnipeg Electric Street Railway Company.

The mechanical superintendent of the whole plant is Mr. R. J. Buchanan, who is well qualified to take charge of this splendid plant—a credit alike to the owners and to Western Canada.

INCANDESCENT LAMPS IN COAL MINES.

It is well known that the ordinary incandescent lamp radiates an appreciable amount of heat. This is a fact to be borne in mind always by window dressers and others who are tempted to place the lamp in juxtaposition to combustible material. There is, according to the London Times, another possible danger, and that is in coal mines. Experiments by M. F. Holliday of the Littleburn Colliery have shown, it is said, that a 100-volt 16-candlepower lamp is capable of causing smoke to rise within three minutes when embedded in coal dust, or may cause flame within 25 minutes when laid on the top of coal dust. Again, the investigations recently conducted by H. Hall, one of the British inspectors of coal and metalliferous mines, proved, it is asserted, that when a 16-candlepower lamp was placed upon and partly covered by coal dust an explosion of the bulb occurred at a temperature of 450° F. within four minutes. These experiments further showed that when the heat had increased to a certain point spontaneous combustion began to operate and the temperature continued to rise until the coal caught fire, although the lamp had been removed for some time.

ECONOMY OF ARC LAMPS.

The Elektrotechnische Zeitschrift publishes a long discussion of the economy of various types of arc lamps with special reference to the number connected in series. It is pointed out that there are a great many different factors besides energy consumption which must be taken into account in determining the economy of a given type of lamp, and the article contains a number of tables and diagrams comparing the economy of the different lamps with respect to energy consumption alone. The following table gives the watts consumed in order to obtain 2,000 Hefner candles with ordinary carbons and with flame arc lamps;

ORDINARY CARBONS.

110 volts,	2 lamps in series,	1250 watts.
110 volts,	3 lamps in series,	1060 watts.
220 volts,	4 lamps in series,	1575 watts.
220 volts,	5 lamps in series,	1350 watts.
220 volts,	6 lamps in series,	1350 watts.

FLAME ARC LAMPS.

110 volts,	2 lamps in series,	800 watts.
220 volts,	4 lamps in series,	950 watts.
220 volts,	5 lamps in series,	1000 watts.

These results are of interest when lighting installations are planned for towns of medium size. Many customers, for instance, can use two or three arc lamps, but no more. At 220 volts it is necessary to use a larger number of lamps, whereby the cost of installation is increased. Moreover, with the same consumption of energy less light is obtained. Further, it will be noticed that the connection of six lamps in series is not superior to five lamps. It may be different, however, if in a larger installation a certain number of lamps is prescribed. If sixty lamps are required, it will be possible to get more light by connecting six lamps in series than five in series. For instance, 13.2 kilowatts give in such a case 20,000 Hefner candles for ten circuits each containing six lamps in series and each consuming 1.32 kilowatts. The same energy gives 16,800 Hefner candles in twelve circuits each containing five lamps in series and each consuming 1.1 kilowatts. With enclosed arc lamps the energy consumption is almost always higher, enclosed lamps being superior only for small intensities of light. The whole situation is, however, changed if the consumption of carbons, cost of attendance, interest and depreciation are considered. It is shown that for small intensities of light the enclosed lamp is quite economical. The connection of six lamps in series at 220 volts is no more economical than a connection of five. For small light intensities and short hours of burning, four lamps in series may be more economical than six lamps. With the flame arc, four lamps in series at 220 volts are not less economical than five lamps in series. The flame arc lamp is to be taken into consideration only for great light intensities, such as 1000 Hefner candles at 110 volts and 2000 Hefner candles at 220 volts, but for all practical conditions the flame arc is more economical than other types of lamps. The superiority of three lamps in series over two lamps in series appears only at longer hours of burning or with greater light intensity. In every respect 220 volts appears to be less economical than 110 volts for arc lamp installations. There is no difference between alternating and direct current with respect to flame arcs. Ordinarily arc lamps, however, when operated with alternating current, three in series, at 110 volts, consume about 60 to 70 per cent. more energy for the same light than with direct current, three lamps in series, and 40 to 50 per cent. more enery than with direct current, two lamps in series.

OPPORTUNITIES IN THE ELECTRICAL BUSINESS.

The prospects of large financial success of the engineering graduate are the same as those of the graduate of the college of medicine or of law. The great prizes are only for the few. A comfortable maintenance is for the majority, and the failures are no greater in number than in the other professions.

An interesting exhibit of what 100 picked men between the ages of 27 and 43 in the electrical engineering business have done was given not long ago in a paper by George A. Damon, of the Arnold Company, of Chicago, entitled "The Opportunities in the Electrical Business," read before the electrical section of the Western Society of Engineers. Mr. Damon sent a letter of enquiry to 100 of the leading men in Chicago engaged in the various branches of the electrical industry.

The summary of the results of his enquiry was as follows : Young men control the business. The inquiry was therefore confined to men between the ages of 27 and 43 on the theory that the older men are the product of a set of conditions that have passed away, while the youngest men are, as a rule, still engaged in a period of preparation. The 100 men are divided into groups as follows :

	No. of men	Average Age	Average Income
Salesmen	7	33	$2,400
Sales managers	11	36	3,400
Business men	10	36	4,800
Sales engineers	8	35	2,350
Electrical engineers	16	33	2,800
Constructing engineers	6	33	2,850
Electrical experts	8	33	3,200
Operating engineers	3	32	2,250
Operating managers and superintendents	10	34	3,550
Professors and editors	8	34	2,500
Patent attorneys	4	32	4,000
Consulting engineers	9	40	6,400

Total number of men, 100. General averages: age, 33½ years ; income, $3,440

Classified in reference to incomes, the record is as follows :

	Men
Income over $10,000 per year	5
Income between $5,000 and $10,000	9
Income between $2,400 and $5,000	66
Income below $2,400	20
Total	100

Seventy-five per cent. of these men are college graduates. The average age of twenty men who are succeeding without a college education is 36 years, and their success measured by a monetary standard shows an income of $3,670 a year. The average age of sixteen graduates of one university is also 36. Their average income is $4,940, which shows a balance of $1,270 a year in favor of the college education. Mr. Damon says that there are in Chicago at least 100 men whose incomes will average about the same as the first 100 selected. An effort was made to make the list representative, and the men were selected on account of their positions without reference to their incomes.

THE MULTIPLE OPERATION OF TRANSFORMERS

By R. T. MacKeen.

It is universally considered good engineering practice to operate transformer units suitably selected, in parallel. Without this means of increasing the capacity of a generating plant or distributing system, the expansion of the electrical industry would meet with serious impediment. While the advantages of the multiple operation of transformers are very generally appreciated by operating engineers, yet the results of the indiscriminate grouping of transformers in this manner are not so fully realized. It is the purpose of this discussion to present to the reader the principles involved in the multiple operation of transformers and thus endeavor to provide means whereby indiscriminate grouping of transformers can be guarded against and instead a selection and arrangement adopted to accomplish the best results; as will be shown later, the grouping together in multiple of transformers too frequently results in the overloading of some of the units. This in practice is not usually considered, the main object being to get upon the circuit sufficient kilowatt capacity to take care of the maximum demand of the system.

It is often an occasion of some surprise when one or more transformers, part of a system operated in parallel, burn out, without any apparent reason. The capacity of the group of transformers is ample for the maximum demand; it therefore cannot be due to overload, it must be the result of defective workmanship in the transformers, and thus the manufacturer has to bear the brunt of the results of the lack of knowledge or judgment on the part of the operator.

It is obvious that the successful solution of the problem is obtained if we can determine and provide the conditions under which each transformer on the circuit will carry a part of the load proportional to its rated kilowatt capacity output.

Let Fig. 1 represent an arrangement of transformers operating in multiple, with interconnecting leads of negligible ohmic resistance and reactance, and supplying a common load. Also assume the transformers are designed for the same periodicity and primary and secondary voltages; it being obvious that the two latter conditions are absolutely essential for parallel operation.

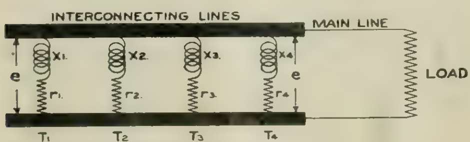
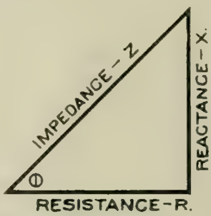


FIG 1.

Let the transformers have resistances $r_1 - r_2 - r_3 - r$ - reactances $x_1 - x_2 - x_3 - x_4$ -, thus having impedances $z_1 - z_2 - z_3 - z_4$ -, it being remembered that the impedance is the square root of the sums of the squares of the resistance and the reactance, and is analagous or equivalent to the ohmic resistance in direct current diction.

The equivalent resistance and reactance of a transformer (i.e., the value representing both primary and secondary resistance and reactance in ohms) bear the same phase relation to each other as the base and perpendicular of a right-angled triangle, the hypotenuse representing the impedance as in Fig. 2.



Φ= PHASE ANGLE.
FIG. 2.

From this relation it is obvious that it is quite possible to have transformers with the same impedance yet widely different values of resistance aud reactance. This suggests a point that should be considered, namely, the difference in phase between the impedance voltages and hence the currents of two transformers having identically the same impedance ohms and voltages (impedance volts being the product of impedance ohms and amperes.) As seen, this is quite possible by varying the lengths of r and x, as shown in Fig. 3. This difference in phase doubtless affects the

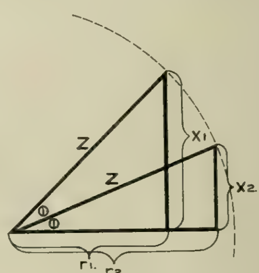


FIG. 3.

distribution of load to some extent, yet the phase difference in practice is so small as to practically be negligible in its results, and in fact it is quite safe to neglect this difference in phase and assume that all commercial transformers may have the same ratio of resistance to reactance, i.e., the same phase of impedance voltage and hence same power factor, yet have widely differing impedances.

Our rules for load divisions are as follows:

First: "When two or more transformers of the same voltage and periodicity are operated in multiple and have interconnecting leads of negligible resistance, as in fig. 1, the loads carried by each will be inversely proportional to their impedances or directly proportional to their reciprocals their admittances."

Second: "The load carried by each transformer will bear the same ratio to the total load as its admittance bears to the sum total admittances of all the transformers."

Just as impedance in alternating current diction is

analagous to resistance in direct current diction, so admittance corresponds with conductance.

It is frequently thought that the distribution of load among transformers is proportional to their percent regulations. This would be the case if the regulation were directly proportional to the impedance, but such is not the case.

It is more usual to express the impedance of a transformer in volts rather than in ohms. The impedance volts are easily determined by short circuiting the secondary and applying a low potential to the primary until full load current is obtained in the secondary. Mannfacturers usually furnish this information on the test card accompanying their transformers. It varies in value from 2 per cent. to 5 per cent. of the primary voltage. As the impedance volts are directly proportional to the impedance ohms either value can be used in the rules given above, the only difference being that the impedance volts must be expressed in terms of unit load for all the transformers. This follows from the fact that the impedance volts is the product of impedance ohms and amperes, and varies with the load. For example, a 10 Kw. transformer has an impedance voltage of 4 per cent. at rated full load, or at unity load of $\frac{4}{10}$ or .4 per cent.

Now since admittance is the reciprocal of impedance or $\frac{1}{z}$ the admittance for the above transformer is $\frac{1}{.4}$ or 2.5, which we might call for simplicity the relative carrying power of the 10 Kw. transformer as compared with any other fransformers operated in multiple therewith.

Right here it should be noted that this value of admittance or relative carrying power can be obtained by simply dividing the kilowatt capacity of the transformer by its impedance voltage in percent. For example: The carrying power of the above transformer is $\frac{10 \text{ Kw.}}{4}$ or 2.5, the same result as before.

Now let us apply our rule to the determination of the division of load among five transformers of same voltage and periodicity connected in multiple, assuming as before that the impedance of the interconnecting line is negligible.

Size of Transformer.	Voltage.	Cycles.	Impedance Volts.
5	1040 2080-104 208	60	4.0
10	"	60	3.8
15	"	60	3.5
20	"	60	2.8
25	"	60	3.1

As the division of load is proportional to the relative admittance or carrying power of each transformer, let us first determine these factors.

Size of Transformer.	% Impedance Volts.	Relative Admittance or Carrying Power $= \frac{\text{Kw. Capacity}}{\text{Impedance Volts.}}$
5	4.0	1.25
10	3.8	2.63
15	3.5	4.29
20	2.8	7.15
25	3.1	8.06
75 Kw. Total		23.38 Total Admittance or relative carrying power.

Our rule states: "That the load carried by each transformer will bear the same ratio to the total load as its relative admittance or carrying power does to the total admittance or carrying power of all the transformers," hence the division of load will be determined as follows:

Size of Trans.	Impedance volts at rated load	Rel. Admitt. or carrying Power.	Kw. Load Carried.	of Total Load.	of Rated Load.
5	4.0	1.25	$\frac{1.25 \times 75}{23.38}$ 4.0	5.3	80
10	3.8	2.63	$\frac{2.63 \times 75}{23.38}$ 8.45	11.20	84.5
15	3.6	4.29	$\frac{4.29 \times 75}{23.38}$ 13.70	18.30	91.5
20	2.8	7.15	$\frac{7.15 \times 75}{23.38}$ 22.05	30.60	114.8
25	3.1	8.06	$\frac{8.06 \times 75}{23.38}$ = 25.90	34.6	103.5
75		23.38	75.	100.0	

From this computation we find that theoretically, all the transformers will be carrying less than their rated load except the 20 k.w. and 25 k.w. sizes, which will be overloaded 14.8% and 3.5% respectively. This example serves to illustrate the method to be used in determining the approximate division of load for concrete cases.

It will be noted that the transformers with the higher admittances or relative carrying powers, and hence with the lesser impedances at unit load, assume the greater part of the total load.

So far we have neglected entirely the impedances of the interconnecting lines between the individual transformers and the load. These impedances enter into the problem in practice to the extent that when known they must be added to the individual impedances of the transformers, and from this an expression representing the admittances or carrying powers determined. The difficulty is, however, to determine the line impedances ; consequently, we can only approximate a division of load, assuming that the transformers are symmetrically disposed with regard to the load and each other so that the line impedances can be neglected.

Other factors also enter into the problem if we search for fine distinctions. For instance : The resistances and hence the impedances will vary with the temperatures of the transformers, which are not only functions of the design, but also dependent in great measure upon location and environment.

Before leaving our method of computation and discussing generalities it is interesting to note that when transformers of different sizes but of the same voltage, periodicity and per cent. impedance volts are operated in multiple, assuming negligible line impedance, the load will be divided among them in the ratio of the kilowatt capacity of each transformer to the total kilowatt capacity. For example : Assume a 10 Kw. transformer operating in multiple with two 20 Kw. transformers, all with the same per cent. impedance volts at full load. The 10 Kw. transformer will carry $\frac{10}{20+20+10}$ or 1/5 of the total load, and each of the 20 Kw. transformers will carry 2/5 of the total load. This simple rule follows from the fact that the per cent. impedance volts varies with the load, and at unit load the admittance or relative carrying powers would bear the same ratio to each other as the kilowatt capacities of the transformers.

While an approximate determination of the division of load among transformers as above is most useful, at the same time it is obviously of greater importance to

know exactly the load division in practice, and this can only be determined by actual measurement.

An ingenious current transformer is now on the market which in conjunction with a suitable ammeter can be used for this purpose. The transformer, which has a hinged magnetic circuit, is merely clamped around the transformer lead, and connection made to an ammeter where the actual load is indicated on the instrument. By applying this test to all transformers banked in multiple an exact knowledge of the conditions is possible. When it is found that either due to difference in impedances of the transformers or the lines (the latter as a result of non-symmetrical arrangement), that an equal and proper division of load does not exist, means should be taken to correct these conditions. This can be done either by rearranging the transformers or lines or by inserting suitable reactance coils in the transformer secondaries. Such coils can be obtained from transformer manufacturers, or, as a temporary expedient a coil could be constructed by winding a few turns of insulated wire of the same cross section as the transformer lead about an iron core of sheet iron or iron wire; but a properly designed coil should be obtained from a reputable manufacturer for permanent service.

We may sum up our conclusions as follows:

1. For all pratical purposes the division of load among transformers is independent of their power factors, and depends only upon their impedances.

2. Transformers of the same or different design of the same size and impedance volts connected in multiple arranged symmetrically with respect to each other and the load, will divide the load with practical equality.

3. Transformers of the same or different design and of different sizes and the same percent inpedance volts at rated load, and arranged symmetrically with respect to each other and the load, will divide the loads in the ratio of their rated kilowatt capacity to the total kilowatt capacity.

4. Transformers of the same or different design and of different sizes and different impedance voltages at rated load, and arranged symmetrically with respect to each other and the load, will divide their loads in proportion to their rated capacity when provided with reactances which will compensate for the inequality of impedance voltages at rated load.

5. When the transformers are not arranged symmetrically with respect to each other and the load, the line impedances affect very largely the distribution of load, in possible cases even more than the difference in impedance voltages of the transformers.

6. In practice, it is almost impossible, owing to the continually changing load center and the complex arrangement of circuits to determine the line impedances, and provide for their symmetrical disposition, hence the only practical way of determining accurately the load division is by actual test at different periods of the day and principally under average and maximum load conditions. From such a test the circuit conditions are known accurately and proper provision can be made by a rearrangement of transformers, lines or load; or reactances provided which will enable a more equal division of load to be obtained.

The Canada Carb-Ox Company, Limited, Winnipeg, Man., has been incorporated, to manufacture smoke consuming apparatus.

MR. H. F. STRICKLAND.

Mr. H. F. Strickland, of Toronto, has received the appointment of chief electrical inspector for the Canadian Fire Underwriters' Association, succeeding Mr. A. Bruce Smith. Mr. Strickland has had an experience of eighteen years in electrical work, and, having served three years in the office of his father, Mr. W. R. Strickland, architect, possesses considerable knowledge of building construction, which will be a valuable adjunct in his new position.

Mr. Strickland was born at Peterboro, Ont., April 25th, 1870. After serving in his father's office, he spent several years in shop work and outside and inside electrical construction, being employed in the shops of the Western Electric Company and the old Ball Electric Light Company. He was for four years connected with the Toronto Incandescent Light Company as contract agent, and for two years was on the agency staff of the Canadian General Electric Company. For the past nine years he has been engaged in contracting work and engineering, one of the recent installations for which he was consulting engineer being the power and lighting plant of the Joseph Simpson Company, Toronto. This commission consisted of converting their entire power drives from steam to electric, the installation consisting of a 250 k. w. C.G.E. three-phase generator and twenty-three three-phase 550 volt motors, varying from three

MR. H. F. STRICKLAND,
Chief Electrical Inspector Canadian Fire Underwriters.

to thirty horse power, together with all wiring panels, transformers, etc. Another installation which he supervised was a complete power and light equipment for both the old and new works of the Goldie & McCulloch Company at Galt, Ont. He has also given expert testimony in several arbitrations between owners and municipalities.

Mr. Strickland's business dealings have been characterized by straightforwardness, to which he may attribute in some degree at least his present appointment. He has served the Underwriters faithfully, while at all times aiming to secure justice for all parties. His record is such, therefore, that he may conscientiously ask the support and co-operation of the electrical industry in his new position. He has appointed Mr. Eugene Cutts, of the construction staff of the Toronto Electric Light Company, as his assistant.

Mr. Strickland is a well-known athlete and an ardent follower of the Natatorial art, having broken all long distance swimming records. Last year he made a ten-mile swim from Lakefield to Peterboro, Ont., in five hours and five minutes. He enjoys phenomenal health and has a magnificent constitution. In 1893 he married Miss Hall, second daughter of the late Frederic Hall, Deputy Sheriff of Peterboro, and niece of the present sheriff, Mr. James A. Hall.

UNLOADING ORE BY ELECTRIC MOTORS

One of the most interesting and notable examples of the remarkable advance in modern industrial appliances, is that to be found in the ore unloading equipment of the Great Lakes. The ore unloading facilities of the Great Lakes are far in advance of those in any other part of the world, and at not even the largest ocean ports is reached the marvelous speed of unloading and handling which has been obtained at modern lake docks.

A notable type of the modern equipment employed for the purpose, in fact the one holding the world's record for fast ore unloading, is the Hulett Automatic Ore Unloader, invented by Mr. Geo. H. Hulett, Third Vice-President of the Wellman-Seaver-Morgan Company, Cleveland, Ohio, who are sole builders of the machines.

The general view herewith shows the latest installation of these unloaders, namely, two electrically operated machines at the United States Steel Corporation's National Tube Company's docks, Lorain, Ohio.

An idea of the heavy service required of these machines may be gathered from the fact that they rapidly handle an enormous grab bucket, which, when open, has a spread of over 18 feet, and which automatically digs and conveys from the hatches of the boat ten gross tons of iron ore at a load. This bucket when open can by telescopic motion be extended still farther, so as to reach more than half-way from the centre of hatch to hatch. It is carried at the lower end of a vertical dependent leg suspended from a long pivoted walking beam, which is carried on a carriage or trolley which travels back and forth on the girders of the machine. The operator who controls all the motion of the bucket rides at the lower end of the leg directly above the bucket. By means of hoisting mechanism, the walking beam is made to oscillate up and down, carrying the bucket down into the hold of the boat and up again above the dock. The leg carrying the bucket is mounted on rotating trunnions in the walking beam so that it can rotate in a circle when operating in the hold of the vessel, permitting the bucket to reach out in all directions. It also travels lengthwise of the hatch, to the sides of the boat; consequently the operator is able to reach almost the entire cargo.

FIG. 1.--GENERAL VIEW OF HULETT UNLOADERS ON DOCKS OF UNITED STATES STEEL CORPORATION PLANT AT LORAIN, OHIO.

The travel of the trolley back and forth on the girders carries the walking beam with the bucket out over the boat and back over the dock. To reduce the trolley travel as much as possible, suitable hoppers for receiving the contents of the bucket are mounted between the girders at the front; these hoppers discharge into an auxiliary bucket car.

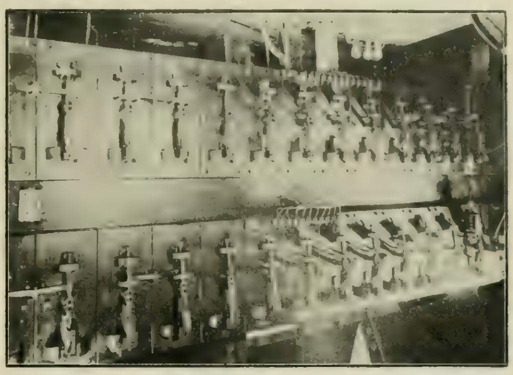


FIG. 2.—MAGNETIC CONTROLLERS FOR HOIST AND TROLLEY TRAVEL MOTIONS.

The Hulett unloaders at Lorain are provided with special cantilever extensions, designed particularly for delivering the ore on a high bank back of the machines. The bucket car travels on these cantilever extensions, automatically dumping the ore at any desired point and returning closed to its position under the hopper. The entire machine is mounted on moving trucks, enabling it to travel up and down the dock from hatch to hatch without moving the boat. The controlling devices for machines of this type are in all cases specially constructed to meet the conditions.

The controllers proper, for this unloader, consist of a number of magnetically operated clapper switches, which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch-panel. The main contact of each switch is a heavy laminated copper brush re-inforced with a yellow brass contact, the final break being taken between carbon contacts, and the arc is quickly ruptured by a powerful magnetic blow-out. The switches are controlled by small master switches located in the operators' cabs. As the solenoids of the switches require but few amperes, the wires connecting the master switch with the controller proper are of very small size.

Each motion of the unloaders is provided with a

positively connected or geared automatic cut-out or emergency switch. The cut-outs on the hoist and bucket-car motions automatically slow down and stop these motions as the limits of travel are reached. They first operate to gradually introduce resistance and slow down the motor; then change connections to

FIG. 3 – MAGNETIC CONTROLLER FOR OPERATION OF GRAB BUCKET.

convert the motor into a generator, and apply a gradual dynamic breaking effect until the motion is nearly stopped, and finally apply band brakes.

The application of dynamic braking to the above mentioned motions is of particular advantage, as the energy of these heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the solenoid band brakes. Under these conditions, the band brakes operate as holding brakes and are required to stop the motion only upon failure of current supply.

The bucket rotation and trolley motions are supplied

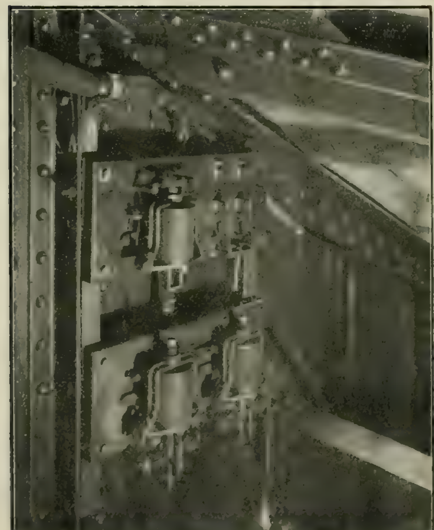


FIG. 4.—MAGNETIC CONTROLLER FOR BUCKET ROTATION MOTOR.

with geared automatic slow-down and cut-out devices, which gradually insert the resistance and finally apply solenoid band brakes to stop the motion as the limits of travel are approached.

While all of these automatic devices fully protect the machinery and motors against failure of current supply, confusion and faults of the operator, still they allow the operator full control of the motors at all times, with the exception that he is unable to pass a predetermined limit of travel of the motions.

The main controllers are located as near to their respective motors as possible, so that the heavy wires carrying large currents are made as short as possible. The master switches, or controllers, are small, thus allowing such an arrangement that all operating handles are brought within easy reach of the operator. They are very easily operated and do not fatigue the operator, thus allowing full output of the machines at all times irrespective of the physical condition of the operator.

The magnetic controllers, which control the movement of the bucket in and out of the boat and the raising and lowering of this bucket, are shown in fig. 2. To the left there are seen four pairs of two switches

FIG. 5.—BUCKET CAR OPERATOR CABIN.

each interconnected by means of horizontal levers. These are the reversing switches and the function of the levers is to absolutely prevent the closing of both reversing switches at the same time. To the right are seen three switches interconnected by means of two levers. The function of these levers is to prevent the closing of the middle or dynamic braking switch when the motor is still connected to the line and operating as a motor. The levers are also used to hold open the switches at either side of the center switch when the motor is acting as a generator with the center switch closed.

Fig. 3 shows the magnetic switch controller for the operation of the grab or clam-shell bucket. The smaller switches, at the left, are the accelerating or resistance switches. These switches are so connected that the succeeding one depends for its closure upon the closure of the one preceeding. One terminal of the operating solenoid of each switch is connected to such a point on the resistance that the current, taken by the motor upon the closing of the preceeding switch, must fall to a certain predetermined value before the following switch can close. This means that the motor must come up to a speed corresponding to each accelerating switch before the following switch will close. This results in the smoothest possible accelera-

tion in the shortest possible time consistent with safety to motor and driving mechanism, and makes acceleration of the motor entirely independent of the operator should he throw the master switch with extreme rapidity.

The result of this design is to cause the motor to approximate almost exactly the operation of a hydraulic or steam cylinder, that is, it will keep a predetermined pressure on the bucket jaws and will not exceed this pressure. The motor is generally stalled once during every closure of the bucket, and this occurs without injury to the motor, controller, or attached mechanism.

The master controller for operating the bucket rotation motor is shown in Fig. 4. This motion operates so easily that the controller is small and requires but few steps.

Fig. 7 shows the magnetic switch controller operating the bucket-car haulage motor. The ore is dumped from the bucket into a car which is pulled up the incline by a motor located in the machinery house underneath the trolley. The car is automatically dumped near the end of its travel by means of mechanical dogs.

Figs. 5 and 6, respectively, show the master controller and automatic slow-down and cut-out switch which control the motion of the car. The manually

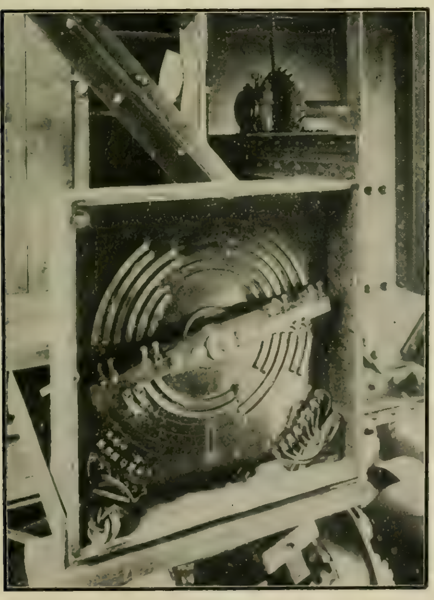


Fig. 6.—Automatic Slow-Down and Cut-Out Switch for Bucket Car Motor.

operated controller to the left of the master controller is used for the purpose of slowing the entire machine so that it may be brought parallel to the hatches of the boat; this dock being built on a large curve makes this motion necessary to secure the best operation. The main controller house is located on the trolley underneath the walking beam and is divided into two parts, one part containing the machinery and controllers, and the other the resistances.

This type of control was designed, developed and built by the Electric Controller & Supply Company, of Cleveland, Ohio, who also manufactured and supplied all magnetic cushion type solenoids for band brakes and all other electrical details.

TRANSMISSION LOSSES.

A measurement of the loss into the atmosphere and over insulations of the two-wire line of the Missouri River Power Company, whose lines run between Canyon

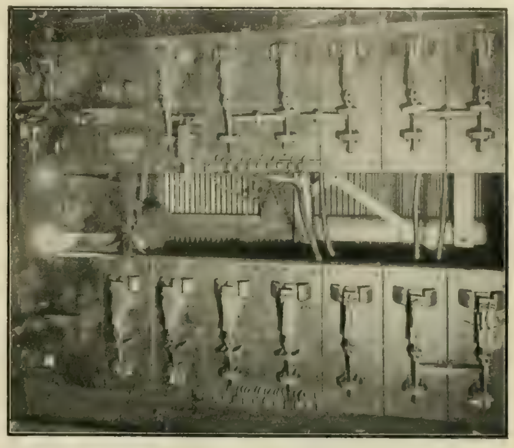


Fig. 7.—Magnetic Controller for Bucket Car Motors.

Ferry and Butte, a distance of sixty-two and a half miles, gave results which show how difficult it is to make provision for all contingencies in high pressure practice. Some of the figures obtained will prove instructive and interesting, in that they show how a higher pressure in the line means a greater line loss in this peculiar way, and a lower pressure the contrary. For instance, with 40,000 volts in the line, the total line loss totalled up to 2,864 volts. Of this loss about 1,644 volts were due to the drop through the line resistance. The balance of 1,220 volts was simply a dead loss of pressure due to the voltage finding a path over the insulators and into the air. According to these particular figures a loss of 5 per cent. in line pressure occurs in this manner. Examining the figures further, as given by Mr. Percy H. Thomas, a pressure of 50,200 volts in the line with the weather wet, meant a loss of 8,120 volts in the line. This remarkable waste of energy itself is a loss of 2,595 volts due to line resistance, and a loss of 1,220 volts through the insulators into the air. With 53,500 volts the total line loss reached 8,892 volts, divided up as follows: 2,940 volts in the line as drop, and 5,950 over the insulators and into the air. With a a final line pressure in this particular test for data, of 61,400 volts, the total pressure loss reached 14,160 volts. This was divided up as 3,830 volts loss in the line through drop, and 10,330 volts loss over the insulators into the air. The fact thus brought to light is that the dissipation of energy through a loss of delivered potential is an important percentage of the total pressure generated or impressed upon the conductors. The 61,400 volts line pressure losing 14,160 volts through the combined effects of drop and leakage, mean more than a 20 per cent. loss in this manner. According to further estimates made, a 150-mile three-phase, 75,000 volt plant would lose about 90 kilowatts total. The loss in the 61,400-volt system of power transmission would average up about 140 watts per mile. On this basis the 62.5 mile run would constitute a loss equal to 135 times 140 watts, or a total of nearly nineteen kilowatts. The result of the continued and complete test seems to show that this radation or leakage of electricity into the air would not seriously affect the efficiency unless the pressure rose to the value of 80,000 volts.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

The Lamp Question. The "free lamp renewal" idea has been thoroughly discussed at some of the recent meetings of Electric Light Associations held in the United States, and as a general thing it may be stated that the large central station has adopted this policy, while the smaller has not and still continues to question its value. While we have devoted much space in these columns to this very subject, the problem to our minds is of such vital importance that we feel justified in bringing it to the attention of our readers once again. As above stated, many of the smaller stations have not adopted the idea, and still doubt the wisdom of the move, but as a matter of fact, they have nothing tangible to show that the idea is wrong. On the other hand, the large stations, who no doubt watch their profits better and with more care, claim to receive annually many times the amount invested in lamps, and when such a statement is made, it is certainly worthy of some consideration. Then here is another feature of the case. Has any company ever adopted the free lamp renewal idea, and then dropped it? All the evidence, and there is much, points in one unmistakable direction, namely, that to furnish the customer with free lamps is one of the most satisfactory and best paying schemes yet introduced in the electric lighting field. The lamps must not be sold at cost, or below cost, or on any such scheme. "Free" has only one meaning, so far as this question is concerned. As an illustration of a condition which may result from the "cost" or "below cost" idea, we would cite a case which recently came to our attention. A local company supplied a high efficiency lamp at the exact cost of the article to them. Competition from an enterprising merchant was experienced, said merchant selling a low efficiency, cheap grade lamp, and using as an argument the statement that it was better in the long run to buy lamps from him, for while they cost a little more, the longer life of the lamp soon made up the difference. It will be appreciated by those who have to deal with the public that this was a forceful argument, and one exceedingly difficult to overcome. To bring in technicalities and show that the saving in current effected by the high efficiency lamp more than compensated for the more frequent renewals is almost useless, for, no matter how much it may be regretted, the consumer often regards the electric company in a far from charitable light, and will likely doubt such a statement. An electric company has competition and serious competition at that. Gas, coal oil, and acetylene, are serious rivals in the lighting field, and it is seldom that the electric company can offer the prospective customer a saving in his light bills. On the other hand, there can be offered a safer and more convenient form of illumination, and if the local manager can truthfully say in addition to these points "a better light," he should get every bit of business in his section. But if his customers buy their own lamps, he cannot say this now, and he never will be able to say it. The lamps in use are as much a part of an electric lighting system as the transformers, the poles, or the generators and engines, and the same careful attention required by and given to these latter items must be devoted to the first. We thoroughly believe in this matter, and we think that every intelligent central station manager who gives

consideration to the question will come to agree with us. Those companies which have adopted the idea have been well paid, whether the plant was on a large or a small scale. Are *you* supplying free lamps? If not, why not? Now is the time to take this matter up, for the season of heavy lighting is at hand, and the old lamps which have managed to burn along through the summer will soon be thrown out. Are you going to let your customers keep on buying inferior, low efficiency, poor grade, long life lamps, and be thoroughly dissatisfied with the service you are furnishing, or are you going to treat the matter as it should be treated, and have all your customers contented? To those central stations driven by steam and supplying energy on a flat rate we would point out that a change from a four watt to a three and one-tenth watt lamp will make a reduction in the coal bill of almost twenty per cent. Is not this worth while?

On Other Lights. Probably one of the cheapest illuminants is coal oil, when calculation is made on a candle power basis, but breakages of glassware, etc., should be added for this form of light, and this is seldom done. Two great dangers are encountered in connection with the use of coal oil, one being the explosion of the lamp and the consequent scattering of the burning oil, and the other the breakage of the oil containing vessel, which act will spread the oil and very probably ignite it. In either accident the fire hazard is very great, and the burning material, namely, oil saturated carpets and perhaps articles of clothing, is very difficult to extinguish. Such accidents happen quickly, and it is very doubtful if the proper appliances will be found at hand to extinguish the flames before great damage has been done and possibly lives lost. Good coal oil itself will not light unless raised to a fairly high temperature, but of course when some fabric is immersed in the liquid there is no doubt about the ignition. With the poorer grades of oil the lighting point is much lower, and in the ordinary types of lamps the construction is so bad that the required temperature may easily be reached while the lamp is in operation. Hence it is probable that in the great majority of cases the oil will light instantly should the lamp be broken, even though setting on an uncovered table. There is no question but that coal oil, while having cheapness to recommend it, is the most dangerous form of light, but while dangerous in itself it has a greatly increased hazard in being portable. If coal oil lamps were all built stationary the risk would be greatly reduced, but without the portable feature it is likely that their use would be entirely dropped. With the gas jet we have two dangers also. The first is the explosion hazard and the second asphyxiation. With the reasonable exercise of common sense this first should be entirely eliminated, but the fact remains that in the past people have looked for escaping gas with a light, and without doubt they will continue to do so in the future. Accidents from this source may be attributed to pure carlessness, and the cure of the evil lies within the powers of each individual. Explosion may come from one other source, but this will be dealt with later. Asphyxiation is the direct result of the inhalation of the gas, but two effects, each entirely separate and distinct, may be noted in the action. The first is the production of unconsciousness, the same being similiar to the action of nitrogen monoxide or "laughing gas" and other similar gases, and the second being a very active poisoning. A person might be kept unconscious with nitrogen monoxide for a number of hours, at the end of which time recovery would be rapid and little or no after effects would be experienced. Here there is no poisoning. But should a person be subjected for the same length of time to illuminating gas, recovery would be very questionable, on account of the severe poison taken into the system. The practice of retiring at night and leaving a jet burning is dangerous to say the least, for should the flame be blown out by a draft, the gas will continue to flow until the cock is turned off. In winter, the chances of having a burning light extinguished are very great, for the following reason. The popular theory that gas or gas-pipes will freeze is of course erroneous. What does freeze is the moisture which is carried into the pipes with the gas. It is possible that where a portion of a pipe is exposed to frost, that moisture coming over with the gas will congeal at this point, and there is risk of the pipe being closed entirely by a continued action along this line. If a person has retired and has left a jet burning, the freezing moisture may be cut off the gas for a time, and then, should a change of temperature occur before morning, allow the flow to continue, and then the gas would escape into the room and possibly cause asphyxiation. If two burners are left going at night, it is possible that one may be extinguished by this freezing and thawing action in the local pipe, and that the gas which escapes into the room as a result will be ignited by the other burner. This is the second source of explosion mentioned previously. The practice of putting an acetylene generator in the cellar of a house will sooner or later make trouble of some kind, and we feel sure that the idea will be given up entirely in the near future. Acetylene, taking all things into consideration, is a safer light than coal oil, and about the equal of ordinary gas. The generator is the danger point, and this is why it should be located in a separate out-house. The gas may be more explosive than coal gas, but there is one point which counteracts this undesirable feature. While acetylene will produce asphyxia, the fatal result of the coal gas is not to be found and the poisoning, comparatively speaking, is very mild. Another good feature is the pungent odor of acetylene, which facilitates the detection and finding of a leak. But regarding this leak question, our remarks on leaks of coal gas apply with equal force here, namely, do not look for the trouble with a light. Acetylene has been condemned in the past, as a large number of accidents have resulted from its use. These lighting systems have been placed in the hands of farmers not above ordinary intelligence, and it is surprising that more fatalaties have not occurred. One man buys a good generator, and has a safe plant, and his neighbor, who is a handy sort of a person, builds a machine himself, uses it, and is, perhaps, blown up. Following this comes a cry from the newspapers condemning acetylene, in every shape or form, and this, to say the least, is most unfair. The party from the country comes into a city hotel and blows out the gas, with inconvenient results, and the papers sneer at the lack of intelligence on the part of the deceased. Far more foolish actions are the cause of many of the recorded explosions of acetylene, but here the system is blamed instead of the individual. Acetylene is a good thing, and will, we think, grow to be a serious rival of electricity. But without question, the electric light is the best, the safest, and most convenient form of illuminant, and coal oil, coal gas, or acetylene, can never be compared wiht it. We place the above facts before our readers so that they may be posted on the various points when going out to secure contracts. We have competition, and will have still more, but the thought that we have an almost ideal form of light should make us feel well satisfied, and should enable us to get and keep a great percentage of the business.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. NO. 1.—Will you kindly explain to me what a "differentially-wound" motor is?

ANS.—We presume that you are acquainted with the standard types of field winding, but will run over roughly the various methods of winding and connecting the coils. The most common winding is the shunt, in which the field is excited direct from the supply circuit and independently of all other parts of the motor. The result of this connection is that the field strength of the machine remains practically constant, and we have, as a result, a machine which runs at a constant speed, that is to say, the maximum variation of the number of revolutions per minute will not exceed five per cent. in a properly designed, fair sized motor. This type of winding is universally used for power work in factories, etc. The next winding is the series, which is used to a great extent for elevator work, and almost exclusively for railways. In this type the field winding is of heavy wire, and is connected in series with the armature, all the current passing through the armature passing through the field also. It therefore follows that when the motor is carrying a heavy load and drawing a large current, the field is very strongly excited, and hence the speed of the machine will be reduced. In this way, the motor has a load-regulating tendency, for if the load be increased the speed immediately drops, which action naturally tends to reduce the load which the machine is actually taking care of. If, on the other hand, the load on a series motor be taken off, the armature current is lowered, and this in turn weakens the field and hence the motor speeds up greatly. Series motors, for this reason, must be carefully watched, for if the load should be suddenly reduced, unknown to the attendent, by such an action as the breaking of a belt, the speed will reach such a high point that destruction may follow, due to the immense centrifugal force. If a machine were built having a shunt and series winding on the fields, the motor would have the valuable load-regulating feature (but not to such a marked extent as would be found in a straight series motor) and would not run away on light load. This is the compound wound motor. It is used on elevator work where the series machine would not give satisfactory results, and has many other fields where the combination of the two previously mentioned features is desirable. An instance can be cited in the case of a punch press. Here it is desired to do the actual punching by the energy stored up in the fly-wheel, and the motor which drives such a press must not reach a dangerous speed when the press wheel is running but the press not working; also, when the actual punching is done, and the speed ofthe fly-wheel and motor is dragged down for an instant, the machine must not take excessive current. The shunt winding of the compound motor prevents the running away, and the series winding prevents the taking of too heavy a current when the speed is reduced. From this it will be seen that the compound motor is an ideal machine for driving punch presses. In the differentially wound motor we have a machine with a shunt and series winding, as in the compound motor, but the difference is that in the former the series field is reversed. This means that when the load is increased the series coils tend to weaken the field, and instead of the speed dropping, it stays constant, or increases. This will of course depend on the ratio of the two windings, for a given machine may be designed to give almost any desired result. Suppose that in a certain motor, the drop in speed from no load to full load, with a shunt winding only, is fifty revolutions per minute. The addition of a series field, reversed so as to make the machine differentially wound, may, dedepending on the number of turns in this series field, give a drop of but twenty-five revolutions, or it may make the speed constant at all loads, or on the other hand, it may make the machine increase in speed as the load increases. Very few differentially wound motors are used, as they have serious disadvantages. Where an absolutely constant speed is required, irrespective of load, is one place for such a motor, but while no trouble will be experiencied if the load changes are gradual, still if a sudden increase in load occur, the motor is liable to run away and blow the fuses. This will be understood by remembering that the series field is opposed to the shunt, and therefore if the increase in load be severe, the series field may completely overpower the shunt field, and the result will be disastrous, the machine being left without any field at all. Another point is that if a differentially wound motor starts to run away, there is no holding it, unless the switch be pulled, and this though it may take but a few seconds will likely give the machine a chance to damage itself. Starting must be carefully done, for the same reasons. While the differentially wound machine is of great value under certain circumstances, it must never be placed in the hands of an inexperienced person who does not understand it thoroughly.

QUES. NO. 2.—When used as a penstock, is the friction greater in an iron pipe than in a wooden one, and how does this vary with age?

ANS.—Considering only iron and wooden pipes which are properly built, it is safe to say that the friction in a new iron pipe of a certain size will be from ten to thirty per cent. greater than that in a wooden pipe of the same diameter. With age, the difference becomes more marked, as the friction in an iron pipe increases while that in a wooden pipe decreases. In an iron pipe, we have the joints, the rivet heads, and the roughness of the iron itself, all of which cannot be materially reduced, and which are material friction factors. On the other hand, the staves of a wooden pipe may be planed very smooth before the pipe is built, the transverse joints can be made practically smooth, and the lateral joints count for nothing. The longer wooden pipe is used, the smoother it becomes inside, owing to the action of the water, and to the formation of a slippery green slime. In making up such a pipe, it is the custom to dress the insides of the staves so that when put

together the whole will form a practically perfect circle. It is a surprising fact that while wooden pipe was used altogether in the early days of hydraulic engineering, steel and iron pipe seems to have supplanted it to a great extent, even where the heads have been very moderate. There appears to be no very good reason for this, as the wooden pipe costs less, is easier built, lasts longer, and has, for a given diameter, a considerable greater carrying capacity.

THE USE OE PORTABLE SUBSTATIONS.

American practice in the field of urban electric railways has conclusively proved the value of portable substation as a necessary expedient on lines having a normally light traffic but subject to heavy rushes of load at certain times. Numerous types of these portable stations have been put into service, and considerable interest attaches to their equipment. In a recent issue of the Street Railway Journal Mr. J. R. Hewett described a station built for the Cincinnati and Columbus Traction Company. From this article we cull the following data:—The equipment under consideration at present forms a 400 k.w. plant. In this instance the machinery and apparatus are installed in a freight car of standard design. Great attention has been paid to the location of the heavier units, to avoid undue strain being brought on any part of the car or machinery during the time it is in motion. The rotary converter is placed at one end of the car and the transformer at the other, in each case the centre of gravity being immediately over the truck. An equipment consisting of a rotary converter and transformer has been found by experience to be preferable to employing a synchronous motor generator set. The former not only has the advantage as regards weight, but it is also less costly, has a better overload capacity, and the connections are simpler. Added to this, were a motor generator set installed, it would involve the use of an exciter set and a high-voltage starting compensator and switches.

The rotary converter installed in the Cincinnati and Columbus substation is a six-pole, three-phase machine, with a normal output of 400 k.w. when running at 500 revolutions per minute. The potential at the d. c. brushes is 600 volts. It is fitted with a speed-limiting device connected up in such a manner as to open the d. c. circuit breaker in case the speed rises above the normal, due to a failure in the a. c. power circuit, when the converter would run as a d. c. motor with a differential field.

In the early portable substations three single-phase transformers were employed. But this was only due to the fact that such apparatus could be obtained at the works ready for immediate use. In the present case, one tri-phase transformer has been installed, and this arrangement possesses the two-fold advantage of being light in weight and occupying a minimum floor space. It is designed for a capacity of 440 k.w., is a 25 cycle unit, and the primary is wound for both 33,000 and 16,500 volts, while the secondary delivers current at a pressure of 370 volts. The blower set for supplying the air-

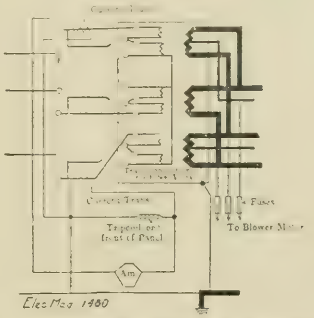


FIG. 2.—TRANSFORMER CONNECTIONS FOR PORTABLE SUBSTATION.

blast consists of an ordinary rotary blower, direct-coupled to an induction motor. No high-tension apparatus is brought in front of the transformer, a factor which ensures the safety of the substation attendant. The usual form of low tension a. c. starting switch is retained, and no d. c. starting rheostat switch or synchronizing apparatus is included in the equipment. Both power factor indicator and a. c. voltmeter are also dispensed with. No negative switch is provided, the negative terminals of the machine being connected directly to the metal truck, which is, of course, in metallic connection with the track. The rotary converter is compound wound, with the series coil on the negative side—that is to say, between the armature and ground connection. An equalizer switch is provided on the negative side of the machine for use when the car is in operation as a reserve to a permanent substation close at hand. The equalizer switch running to a flexible jumper can readily be connected to the equalizer bus bar in the neighboring substation; and, again, the jumper can be connected to the ground should it become desirable to run the converter as a shunt-wound machine.

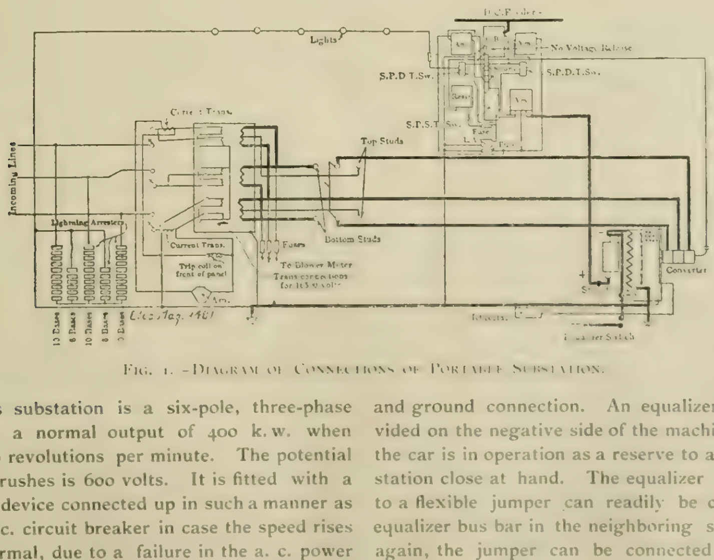


FIG. 1.—DIAGRAM OF CONNECTIONS OF PORTABLE SUBSTATION.

The substation can be lighted from either the trolley

or the rotary converter; and the voltmeter is provided with a double-throw switch to permit readings being taken of either the trolley or machine voltage at will. A flexible lead is taken through the wall of the car directly from the machine circuit breaker to a terminal block on the outside, so that connections may readily be made to the trolley wire, d. c. feeder, or positive bus bar in the permanent substation, as occasion demands. The a. c. leads are carried out through a special weather-proof entrance, and from this point connections are made to the overhead high-tension transmission lines.

The end of the car near which the rotary converter is located is made detachable, to facilitate installation. The rotary converter is held in position by wooden cleats, which fit snugly to the interior form of the base, and provision is also made for levelling the rotary converter, should it be found necessary for the substation to be operated on a grade. All the wiring from the transformer to the rotary converter is carried under the floor.

Figs. 1 and 2 show the scheme of connections diagrammatically. In the former the transformer connections are for 16,500 volts, and in the latter for 33,000 volts.

The approximate dimensions of the car are:

Length	41 ft.
Width	9 ft.
Height	8 ft. 6 in.

The car is fitted with hand brakes, but no motors are installed, as their occasional use would hardly justify the extra expense. When the substation is moved, it is drawn by a motor car. During transit over the steam railroads, standard M. C. B. wheels are used, but when the car reaches its destination, these are replaced by wheels of narrower tread and shallower flanges, suitable for running over city lines, switches and points, as well as rounding curves, etc. Cars for operating on lines where little clearance is provided between the top of cars and bridges can be supplied with hand brake rigging mounted below the roof line.

A NEW SYSTEM OF STREET LIGHTING.

Publicity has recently been given to an arc lighting system employing the mercury vapour rectifier as the "changing medium between the lamps and the generators." The following details describe generally the system adopted:

The feature of the system is the operation of direct current arc lamps, of either the carbon or luminous arc type, from an alternating current supply by means of a constant current transformer and a mercury arc rectifier, thus obtaining both the excellent light of the direct current lamps and the perfect regulation of the constant current transformer, through the medium of a reliable, efficient and simple piece of apparatus.

The remarkable properties of the mercury arc rectifier for low-voltage applications are now well known through the recent introduction of the battery-charging rectifier panels. Therefore, no theoretical discussion of the rectifier tubes will be attempted. A few changes in shape from the form of the low-voltage tubes have been found advisable, and a few additional precautions are taken in manufacture, on account of the high voltage to which the tubes are subjected when operating series street lighting circuits. Naturally, difficulties have been met in handling high voltages, but they have not proved insurmountable, and to-day 25,000 volts are handled with the rectifier much more easily than one-hundredth of this voltage was controlled only a few years ago.

The transformer used to supply the lighting circuit through the rectifier is of the well known constant current type, air cooled except in the largest sizes, where, on account of high voltage, oil cooling is preferable. It differs from the standard type only in that it requires a specially wound secondary, having a smaller section of wire and greater number of turns than is usually employed. These special secondaries are usually wound in two coils, thus giving a convenient neutral point to which the negative terminal of the road is connected.

The first commercial installation of luminous arc lamps operated from a rectifier was made by the Schenectady Illuminating Company in March, 1905. The lamps are placed on Dock Street, Lyon Street, and Edison Avenne, and have been operated from the rectifier without the slightest trouble or interruption since that time, thus confirming the results of earlier tests, that the system is efficient and reliable.

The rectifier is mounted on a pivoted support on the front of the arc light controlling panel. A modification of this arrangement adopted in later sets has been to mount the rectifier on a small marble base and to mount this base above and back from that part of the panel on which the operating switches are located. This arrangement entirely avoids the presence of high-potential terminals on the front of the panel. A small transformer supplies low-voltage alternating current to a pair of auxiliary starting anodes; consequently, the rectifier may be started before any of the high-tension plugs are thrown in. After starting the rectifier it is necessary only to plug in the circuit and transformer plug switches, starting as though the system were series alternating.

The efficiency of the rectifier system is practically the same as that of the constant current series alternating arc light system, since at the high voltages used the loss in the rectifier becomes almost negligible. In light efficiency, however, the rectifier luminous arc system shows a marked advantage, on account of the great increase of light given by the luminous arc lamp at approximately three-quarters the energy. Although the same increase of light, due to the use of the magnetic arc lamp, may be obtained from a motor-driven arc light dynamo, there can be no comparison between this method of operation and the rectifier, either in efficiency of the system, amount of apparatus, or ease of operation.

The Board of Trade of St. John, N.B., have appointed a committee to enquire into the feasibilty of obtaining cheap power from a near-by falls, a project brought up recently by William Thompson & Company.

The British Columbia Electric Railway Company are considering the building of an electric railway from New Westminster to the Fraser River saw mills at Millside. It would mean an expenditure of approximately $35,000.

The improvements to the electric light plant at Parry Sound, Ont., have been completed. A flume 130 feet long has been built, the power house remodeled and a new revolving field alternator installed. The power has been increased to 700 h.p.

CANADIAN ELECTRICAL ASSOCIATION.

A meeting of the Executive Committee was held at the Secretary's office, Toronto, on the 11th inst., when a number of new members were elected.

Owing to his removal to New York, Mr. K. B. Thornton, ex-President, tendered his resignation as a member of the committee. Mr. James Robertson, of the Montreal Light, Heat & Power Company, was elected as his successor.

A letter was read from the Institution of Electrical Engineers of Great Britain tendering to the Canadian Electrical Association an invitation to visit England during the latter part of the month of June next as the guests of the Institution. The Secretary was directed to express the thanks of the Association for the invitation and communicate with the members to learn if any of them will be in a position to avail themselves of it.

Messrs. R. G. Black and James Robertson were appointed a committee to secure suitable papers for the annual convention of 1906. The following gentlemen were appointed a committee to make the necessary local arrangements for this convention :—Messrs. R. B. Hamilton, manager Packard Electric Company, St. Catharines; J. A. Kammerer and J. W. Campbell, Toronto; P. J. Myler, manager Canadian Westinghouse Company, Hamilton, with power to add to their number. It was suggested to this committee that if possible the convention be held during the first two weeks in June.

Mr. R. G. Black was appointed Chairman of the Committee for the advancement of the interests of the Association. Mr. T. S. Young was appointed Assistant to the Secretary of the Association.

TORONTO BRANCH A. I. E. E.

The twenty-fifth annual meeting of the Toronto Branch of the American Institute of Electrical Engineers was held at the Engineers' Club rooms, 96 King street west, on Friday evening, November 10th. The subject for discussion was "Lightning Arresters," which was introduced by Mr. C. H. Wright, who gave an abstract of a paper read before the parent institute by Mr. N. J. Neall. This paper describes a method of obtaining, by means of test papers, records of the operation of lightning arresters in service and gives some results obtained by the use of this method on several transmission lines. The test papers were furnished by the Westinghouse Electric & Manufacturing Company to a number of operating companies about eighteen months ago and the tests covered territory extending from Maine to California. The character of the puncture made in the test papers, which were inserted between the discharge points of the arresters, is believed to indicate not only that a discharge had taken place, but also to show its character and thus give evidence of the suitability of the protective apparatus employed. The range in voltage of the high tension plants on which experiments were made extended from 6,600 to 55,000.

The test papers are stated to indicate that the lightning disturbances on a line are not of the magnitude generally supposed. A comparison of the lightning arrester papers punctured in practice with the papers taken from idle lines led to the belief that the low-equivalent arrester was discharging these disturbances almost as freely as if the resistances were omitted. The results showed clearly that for freedom of discharge the arresters which are built like the low equivalent with low resistance have freer discharge than the straight gaps and high resistance.

Mr. Wright strongly commended the Westinghouse Company for the work which they had undertaken, and which he believed would eventually lead to a more perfect knowledge of the characteristics of lightning discharges. He regarded Mr. Neall's paper as a very valuable addition to scientific literature.

An interesting discussion followed Mr. Wright's remarks, in which Messrs. H. A. Moore, R. G. Black, K. L. Aitken, E. B. Merrill, W. G. Chase, E. Richards and F. A. Gaby were participants. Mr. Moore urged that the electrical fraternity of Canada take some steps to ascertain the effect of lightning discharges upon transmission lines in this country, where climatic conditions are different from those of the United States. No particular type of arrester, he claimed, could meet the requirements of all lines and all conditions. Mr. Black advised that fuses be placed on both sides of lightning arresters to prevent them from short circuiting. If he were building a line he would have a plain wire above, with a large number of lightning arresters. Mr. Merrill described briefly what the Toronto and Niagara Power Company are doing in the way of lightning protection. During the discussion the horn type of arrester, which had been discredited by some engineers, was the subject of favorable comment. It has been used very successfully on the transmission line of the Shawinigan Water and Power Company between Montreal and Shawinigan Falls, and since their installation they have had no arcs in their station, no damage to apparatus, and no interruption to their service caused directly by lightning. This type of arrester is evidently used largely in Italy, as Mr. Philip Torchio, in a paper read at the last Institute meeting in New York, states that the best practice in Italy consists in placing horn arresters on the line at the station, making the ground connection through a water rheostat.

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
38 Alliance Building.

November 4th, 1905.

Last year the Montreal Street Railway caused considerable comment by leasing one of their cars, as an observation car, to a Buffalo concern. The business public thought it strange that the company did not run it themselves. The cab drivers fought the scheme tooth and nail. This year the company are running it themselves, and utilizing the fine new open car that made its debut at the late C.E.A. convention in Montreal. The business men nod approval, the tourists are satisfied, and even the cab driver has not been heard against this latest scheme.

It is a pity that much cannot be said for the new double entrance closed cars numbered from 900 upwards, that the Montreal Street Railway Company have placed on the St. Catherine street route. The idea is to prevent one from securing a ride for nothing by compelling payment on entering. Whilst a man can get his cash or ticket easily, or should be able to do so, it is a different matter with the ladies, and surely they are not the ones that cause the Montreal Street Railway to mourn the loss of so many fares? An exception might surely be made in their case, as encumbered with parcels and passing through a phalanx of smokers, it is hardly to be wondered at that the ladies object to such "stand and deliver" methods.

The Bell Telephone Company deserve great credit for the success which attended the turning over their main exchange to central energy system. Saturday we turned magnetos, Monday we did not. No time lost, and complaints were few and far between. It would be interesting to learn from that company's engineers if ever another exchange of such magnitude was changed over in such a manner and without loss of service.

THE BRAIM AUTOMATIC SWITCH.

A company has been formed in Vancouver, B. C., for the purpose of placing on the market a patent switch turning device, the invention of Mr. W. H. Braim, of that city. This switch was first introduced about two years ago, at which time it was taken up by the British Columbia Electric Railway Company, and after several satisfactory tests was installed throughout their system.

The device, while unique itself, is very simple in operation. It consists of three distinct parts, each, of course, operating on the other. The first part is that with which the cars are equipped, being a long pin or tread acting on a shoe made suitable to engage either catch to throw switch for main line or branch as desired. The top of this pin protrudes through the platform of the car in a convenient place for the motorman to operate, which is done by the pressure of the foot.

The other parts are placed on the ties at the switch and consist of two cast iron boxes and a common T rail about five feet long. This rail is simply for the lower end of the shoe to travel along when pressed downward by the motorman as the car approaches the switch. At the end of this rail nearest the switch is located one of the cast iron boxes. This box is about 6 feet long by 4½ inches wide, rising level with the rails. Near each end of the box is a small case hardened catch or block, one or the other of which the lower end of the shoe on the car strikes. These little blocks slide forward or backwards in a guide frame and are made to work opposite one from the other by means of a flexible connection (either chain or cable) working around a pulley located inside the box. Thus when the shoe strikes one of the blocks throwing it forward, the other one being connected to it by the cable is immediately thrown back in readiness for the reverse operation.

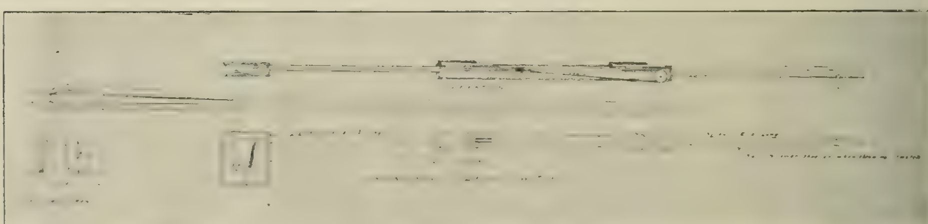
Along side the switch and in line with the first mentioned box is placed another cast iron box. This one is nearly square, being 16 x 18 inches, and rises level with the pavement. This box contains a T shaped lever; to one end of the short arm of this lever a link is attached, the other end of the link being connected direct onto the switch point. It might be mentioned in passing that this link is in two pieces, the connecting ends being threaded to permit of perfect adjustment in the play of the link on the switch.

Coming back to the long box, we find a long shaft or sliding rod running from it to the second box. This rod has a sliding play of about six inches and is operated by the two catches at each end of the longer box. It is connected at the other end onto the long end of the T shaped lever in the square box.

Let us suppose now that a main line car is approaching a switch that has been thrown over for the branch line. The motorman presses down the trip with his foot as the car approaches the first catch situated in the forward end of the long casting. The toe of the shoe striking this catch immediately shoots the long sliding shaft forward, which shaft, pulling at the long end of the T lever in the other casting, causes its short arm to move about two inches. The connecting link, being attached to the short arm of this lever, instantly moves with it, and it (the link) being also connected to the switch point, pulls the switch point over, permitting the car to continue on the main line. If a branch line car is approaching the switch when it is thrown for the main line, the motorman of the branch line car allows the shoe to pass over the first catch and striking the second causes a reverse movement of the long sliding shaft, thereby moving the switch point over for the branch line as desired.

Braim Patent Railway Switch—The Depressible Shoe is About to Strike the Trigger of Switch.

The object of placing the first box so far back is to allow the motorman to see that the switch has been moved over before the car enters. The two boxes or castings, as they are usually called, are connected to each other by a piece of piping which also serves to encase the long sliding shaft.



Arrangement of Braim Patent Railway Switch.

The following are the instructions that have been issued by the British Columbia Electric Railway Company to their employees for the installing and operating of the switch-thrower:

DIRECTIONS RE. INSTALLATION.

The switching device consists of two parts, the switch throwing lever attached to the car-body and the device installed on the street railway track between the rails.

To install, first drill the tongue switch about 22

back from the tongue, making a rectangular hole 1½" × 1⅛" as per separate detail; fit the dog to tongue and connect to the lever in cast-iron box by the connecting rod provided. Then place the 1½" wrought iron pipe that serves as a cover for the long connecting rod in position, fitting one end in the square box and the other end in the long casting, driving the pipe into place to the mark on the pipe.

Connect up the levers and the chain to the two triggers, making sure that all parts are in line and work easily before spiking down.

Spike down a short length of rail about 6 ft. long for the shoe on switch to run on.

In equipping car with switch thrower make sure it is the same distance from gauge line of rail as the triggers on the track and see that the shoe and lever have not too much side play.

The operating rod in floor of the vestibule can be off-set to bring it into the best location for the motormen's use. This position will naturally vary with the different types of vestibules.

DIRECTIONS TO MOTORMEN TO THROW SWITCH.

To throw switch for main line press the pin just as first trigger in long casting rod disappears under the fender, holding shoe steadily until switch is thrown.

To throw for branch line press the pin at the second trigger just as the one nearest switch disappears under the fender. Always slow car down to 2 miles an hour when operating switch thrower, and release foot from pin as soon as the switch is thrown.

ELECTRIC COMPANIES IN DISPUTE.

As a result of an electric fire, which burned out a whole light and power circuit at the power house of the Montreal Light, Heat and Power Company and temporarily tied up the street car service, the latter company has entered suit against S. Carsley, of the Central Electric Company, for $150,000 damages, and applied for an injunction to prevent the latter company from stringing wires as heretofore.

The Montreal Company say that the fire was caused by one of the Central Company's wires, which crossed their 10,000 volt wire, falling on to their wire. The immediate result was a short circuit.

The Carsley system was started for his own departmental store, and was extended by running the wires over the roof, etc., to supply other nearby merchants.

The management of the Montreal Light, Heat and Power Company issued the following statement respecting the trouble:

"Due to gross carelessness on the part of the emloyees of the Central Electric Company, the system of he Montreal Light, Heat and Power Company was seriously interrupted yesterday morning. Employees of the Central Electric Company by stringing wires over the high tension lines of the Light, Heat and Power Company on McGill street, burnt the same down, which caused a complete shut down of all services fed from the Light, Heat and Power Company's central station, which seriously affected the operation of the Montreal Street Railway Company. It is miraculous that there were not a number of people killed due to this carelessness. Considerable damage has been done to the system of the Montreal Light, Heat and Power Company, as well as the Street Railway Company."

AN IMPORTANT DECISION.

An important decision has been rendered by Judge Andrews in the case of the Guardian Fire and Insurance Company vs. the Quebec Railway, Light and Power Company, which was an action for $2,300, and also in the action of the Union Assurance Society for $2,565, against the said company, both actions being dismissed with costs.

The Insurance Companies were endeavoring to recover from the Quebec Railway, Light and Power Company the above amounts, paid by them to J. B. Morrissette and wife for damage to their property, caused by fire about October 18th, 1903.

The Insurance Companies claim that the Quebec Railway, Light and Power Company were responsible for the damage. The case was a very important one, and the trial lasted almost two weeks. There were nine expert witnesses retained by the plaintiffs and defendants. The technical side of the Quebec Railway, Light and Power Company's case was placed in the hands of Mr. R. S. Kelsch, consulting engineer, Montreal.

From the evidence given, it was learned that the transformer supplying current to Mr. Morrissette's house failed on the night of the fire. The record of the weather conditions for that night, however, were such as to show that a very severe thunder-storm, accompanied by sharp lightning discharges, occurred, and that, furthermore, the wiring in Mr. Morrissette's house was defective in several respects. The evidence also showed that the wiring was done by a man who knew nothing about the business, and even the Fire Underwriters' experts were obliged to admit that it was very defective.

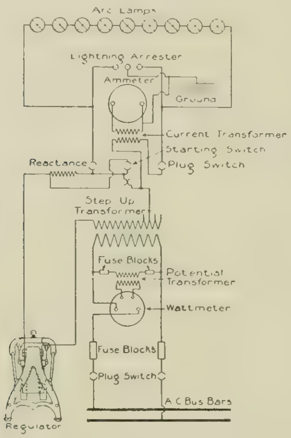
In one place concealed work was done with ordinary lamp cord, which was twisted around a lead pipe, ¼-inch lead pipe being used throughout the building for connecting the various gas fixtures.

MOONLIGHT SCHEDULE FOR DECEMBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Dec. 1	5 00	Dec. 2	6 30	13 30
2	5 00	3	6 30	13 30
3	10 30	4	6 30	8 00
4	11 30	5	6 30	7 00
6	0 20	6	6 30	6 10
7	1 15	7	6 30	5 15
8	2 15	8	6 30	4 15
9	3 10	9	6 30	3 20
10	4 10	10	6 30	2 20
11	No Light	11	No Light	...
12	5 00	12	7 00	2 00
13	5 00	13	7 50	2 50
14	5 00	14	8 50	3 50
15	5 00	15	9 50	4 50
16	5 00	16	10 50	5 50
17	5 00	18	0 00	7 00
18	5 00	19	1 00	8 00
19	5 00	20	2 10	9 10
20	5 00	21	3 20	10 20
21	5 00	22	4 30	11 30
22	5 00	23	5 40	12 40
23	5 00	24	6 45	13 45
24	5 00	25	6 45	13 45
25	5 00	26	6 45	13 45
26	5 00	27	6 45	13 45
27	5 00	28	6 45	13 45
28	5 10	29	6 45	13 35
29	5 10	30	6 45	13 35
30	5 10	31	6 45	13 35
31	5 10	Jan. 1	6 45	13 35
		Total.	......	264 25

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Series Alternating Current System for Arc Lighting.—The Fort Wayne Electric Company, of Fort Wayne, Ind., have recently developed a system for series arc-lighting circuits which may readily be operated upon a constant-potential supply. The system has been designed for a frequency of either 60 or 140 cycles, and consists of a regulator for maintaining a constant current, a specially designed high-tension switchboard, a constant-potential transformer, and a series of arc lamps. The regulator depends upon the automatic introduction of impedance



CONNECTIONS FOR FORT WAYNE SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING.

into the lamp circuit whenever any decrease in the resistance of the latter would tend to cause an excessive current to flow. This impedance is introduced by the combined movements of a laminated iron core and impedance coil into such a position as to cause a greater magnetic flux to be cut by the current in the coils. This increase in the amount of flux cut by the line current produces a choking effect, reducing the latter to its normal value. If, for any reason, the line current be decreased, the exact opposite effect takes place within the regulator, and the current is automatically increased to its normal value. By reference to the accompanying diagram, the peculiar design will be noted by means of which, it is claimed, the system may be quickly started from the switchboard without paying any attention to the regulator and without causing any excessive rush of current through either the regulator or the lamps.

The Tantalum Lamp.—Concerning the tantalum lamp, Mr. V. Zingler, of Siemens Bros. & Company, London, Eng., says: "Many hundreds of thousands of these lamps have now been sold, and a considerable amount of experience with regard to their behavior has been obtained. As a result, it has been shown that when used on alternating-current circuits the results are not so good as on continuous-current circuits, the life of the lamp frequently being considerably shortened, and the globe showing a tendency to blacken. We therefore recommend that, for the present, the use of tantalum lamps should be restricted as far as possibe to continuous-current circuits. We are frequently asked to state the life of the lamps. Of course, as regards individual lamps, it is as impossible to make any statement as with any carbon filament lamp, but experience has shown that on continuous-current circuits the useful life may be assumed generally as being between 400 and 600 hours, and in many cases it is actually even larger, whilst the total life often greatly exceeds 1,000 hours. We have previously informed you that the candle-powers of the lamps of various voltages are proportional to the standard candle-power of the 110 volt lamp (23 British candle-power). We have had many enquiries as to why we do not put the 110 volt lamp on the market with a candle-power somewhere about 16, the general opinion being that 23 c.p. was too high for most requirements, although the current consumed is actually less than for the carbon filament lamp of 16 c.p. According to present manufacturing arrangements, in order to reduce the candle-power, it is necessary to have a lower voltage lamp, so as to secure the same high efficiency. We are now prepared to accept orders for 2.2 watt lamps for pressures of 50, 55, 60, 65, 73-75, 100 and 110 volts. These lamps have a useful life of about double the duration of the lamps described above, and give 30 to 40 per cent. less light, with an efficiency at starting of 2.2 to 2.4 watts per candle-power. For instance, the 110 volt lamp of this type gives a light of about 14½ c.p., with an efficiency of 2.2 watts per candle-power. Its useful life is about 800 to 1,000 hours, and the total life often reaches 1,500 to 2,000 hours. With the efficiency mentioned, a lamp having such a long useful life is, you will no doubt agree, a great improvement on anything that has been done in connection with carbon filament lamps."

Terminal Covering for Lead-Armored Cable.—Chas. E. Teush and Luther Agis, of Evansville, Ind., have patented a moisture-proof cable covering which contains some points of advantage. The invention consists of a sleeve of lead or other suitable material forming a case-covering for the splices and joints. This covering is healed or completely closed at one end, while the other end is "sweated" to a collar of brass or other suitable material provided with a screw thread on its outer extremity to fit the internally screw-threaded lower end of a cap of brass or other metal. This cap is provided with an internal annular ledge and an extended rim or margin above the ledge, creating, with a lead gasket resting upon the ledge, a shallow cup on the top of the complete casing. The gasket is provided with a series of holes for the reception of any number of lead-armored cables that it may be desired to use, hot solder being poured around the cables in the shallow cup formed, preferably until the

solder rises to a line a little above the top of the cap. By the use of this device it will be seen that to reach the terminal wires to make splices or tests all that is necessary is to unscrew the brass collar from the cap, when the hollow casing may be removed and the wires exposed.

Improvement in Telephone System.—Mr. Charles E. Egan, of Chicago, has been granted a patent on a telephone system and has assigned same to the Egan Electric and Telephone Company, of Petersburg, Ill. The invention relates to improvements in telephone systems in which a number of telephones are arranged on a single circuit, and the object is to provide a simple means whereby the operator at the central station may cut out the coil and bell circuits of all the intermediate telephones while conversation is held between two subscribers at the remote stations, thus reducing the resistance in the talking-circuit. In carrying out the invention, a circuit controller is employed comprising a metal plate adapted to form part of the circuit. Chambers are arranged in the circuit and have corrugated expansive inner walls. Swinging rods have connection with these walls, and are adapted to operate a circuit controller. Heat coils are located in the chambers, and means are provided at a central office for controlling the heat coils.

Direct Current Series Power Transmission System.—A British exchange tells of an interesting high tension direct current transmission scheme. The transmission is between Montiers, in Savoy, and the town of Lyons, and is over a distance of 110 miles—the greatest yet undertaken in Europe. The power to be transmitted is 6,500 h.p., and it is to be generated at 57,000 volts. This will be obtained by connecting four groups of generators in series, each group being directly driven through a flexible coupling by a turbine of 1,570 h.p. Four generators, giving 3,560 volts each, form a group. The receiving station at Lyons will contain six groups of motors coupled to tramway generators. Each group will consist of two motors, each taking 73 amperes at 3,840 volts. In this installation the earth is employed to limit the static voltage of the line, but it does not actually form one of the conductors, except in case of accidental damage, in which case it acts as a reserve line. In this way the cost of the line is practically the same as when the earth is used as the return, while certain useful advantages are obtained. Thus the stray currents are, normally, entirely suppressed, and, in case of breakdown, are reduced by half, whilst another important advantage is the fact that the earth is always available as a reserve line in case one of the conductors fails.

The Cascade Rotary Converter.—A 75 k.w. cascade rotary converter is now being exhibited at the Liege Exposition and has attracted considerable interest. This machine is designed for the transformation of alternating into direct current. It partakes of the characteristics of a motor-generator and of a synchronous converter fed through stationary transformers. The converting equipment is composed of two machines, which may be designated as the input and output machines, respectively. The input machine consists of a rotor and stator, similar to those of an induction motor. The output machine consists of armature and field structures, similar to those of a rotary converter. The rotor of the input machine is mounted on the same shaft with the armature of the output machine, and the rotor (secondary) winding is connected directly to the armature winding.

The operation of the equipment presents numerous points which are well worth mentioning. If it be assumed that the input machine has the same number of poles as the output machine, then the normal speed is equal to just one-half of the speed of the revolving field of the first machine (induction motor). Consider the action of the stator circuits of the input machine. When a certain alternating e.m.f. is impressed upon its terminals, the flux must have a value such that its rate of change produces a counter e.m.f. only slightly less than the impressed. When the primary circuits are symmetrically arranged and subjected to polyphase electromotive forces, the familiar synchronously revolving field is produced. This field cuts across the secondary conductors and generates therein electromotive forces having a frequency proportional to the slip from synchronous speed. The electromotive forces generated in the armature of the output machine, due to its motion through the constant field, will be proportioned directly to the speed. It is evident that these two polyphase electromotive forces will have the same frequency at a certain speed of the rotor, which speed will be one-half of that of the revolving field when the poles of the input and output machines are equal in number.

In comparison with the ordinary rotary converter, the cascade converter possesses the advantage of operating at a lower frequency, and hence its commutation is much better. The input machine can be wound directly for any voltage, and hence stepdown transformers are unnecessary. The makers claim that it it is much lighter and cheaper than a motor-generator set. It is a synchronous machine, but can be started as a simple polyphase induction motor. It supplies its own exciting current, both during the starting period and during normal operation. On the input side its performance is similar in many respects to an induction motor operating at variable slip near synchronous speed, while on its output side it possesses the characteristics of a synchronous converter.

Efficiency of Incandescent Lamps.—Recent tests were made in Paris by Lauriol and Janet for a special purpose of comparing 110-volt and 220-volt incandescent lamps. The results of these tests support the contention that 110-volt lamps are better than 220-volt lamps in point of efficiency (average difference about 20 per cent. in favor of 110-volt lamps), useful life and similarity in illuminating power. After 200 hours the average consumption of the 220-volt lamps tested was 34 per cent. higher than that of the 110-volt lamps. Janet points out, however, that the use of 220-volt lamps is only now becoming common in France and that it would be unfair to form final conclusions as regards 110-volt lamps versus 220-volt lamps from the figures quoted.

New Type of Gas Producer.—In a recent issue of the Zeitschrift des Vereines deutsches Ingenieure, Herr Jahns describes a form of gas producer developed by himself, in which such cheap fuel as bituminous coal, slack and the refuse of screening and washing operations may be used successfully to produce a gas suitable for driving gas engines. The gas is not produced complete in one generator, but passes through a series of four or more, which are interconnected. As gas is being produced, generators are being cut into and out of the series. Each generator is filled full with fuel at the start and no more is added until after it has burnt out. The gas coming from the generator last fired up passes through those already in operation, and thus its quality is fixed, although it contains a high percentage of volatile matter. There is claimed for this type of producer a less cost of production and a more efficient generation of gas.

UTILIZATION OF GAS ENGINES IN CONNECTION WITH LONG DISTANCE ELECTRIC TRANSMISSION.*

By John Martin.

The very rapid progress in the development of electrical machinery and appliances during the past ten years has invited the capitalist and engineer to install and operate many hundred thousand horsepower, utilizing the waters of the various streams as a source for generating the current. The prime incentive for such development from the investor's standpoint was the fact that the source of power was being constantly renewed by the laws of nature, and with the authentic records of precipitation as a guide the prudent engineer has recommended a great many plants to be constructed which have proved financially and commercially successful.

The most notable examples of this progress have been and are being developed in the State of California. A great many surprises of a practical nature have been encountered by the managers of these various water-power electric developments with particular reference to earning capacity, and more particularly with reference to the relation of "plant utility to plant capacity," commonly termed "load factor." The manager is constantly trying to find ways and means of utilizing the electric current during such times of the day or night when his present consumers do not require it. Numerous plans and devices have been utilized to further this end.

Within the past year, the problem was presented to the officers of the California Gas & Electric Corporation, who were desirous of furnishing all the electric current for the operation of the street railroads under the control of the United Railroads of San Francisco, and negotiations were commenced with the officers of the latter company with that end in view. It was very difficult for the railroad people at first to develop even a hope that such a condition of affairs could be made feasible. Here was a company with its thousands of horsepower developed at no point nearer than 140 miles from the proposed place of consumption, and while it is true that this company has many sources of supply and many avenues of delivery, yet there was an insurmountable barrier in the minds of the railroad people as to the advisability of purchasing current at any price if the convenience of its patrons was to be sacrificed in any way. As one of the officers of the railroad company remarked, "We certainly desire to save money in the operation of our property—within reason, but at the same time, we care more for the good will and satisfaction of our patrons, and if any interruption of service should occur on all your lines feeding into this city at one time we cannot expect our citizens to be patient while sitting in the cars for an hour and a half until you get up steam."

The railroads were operating their steam plant for this service, and the power company suggested the continuance of the operation of these steam plants and receive a portion of the power from the power company, but this plan was not considered advisable.

After numerous interviews with an honest desire on both sides to try and accomplish the economic result, if it could be done without sacrificing the interests of the patrons of the railroad company, a firm conclusion was reached that in a service so large and important as the carrying of hundreds of thousands of people daily in a large city, nothing could be done on the plans outlined unless some absolute guarantee of continuity of service were available, and it certainly was not favorable from the standpoint of the utilization of steam engines for emergency purposes, because if steam were being maintained constantly under the boilers, no economy could result, and if the plants were allowed to cool off the time element of starting would prohibit their use.

The officers of the power company had been making thorough investigations of the development of the gas engine in large units, having sent two of their engineers througout the entire East to make full and complete reports. In consequence, and as a last resort, the power company agreed to install three gas engine electric generating units, each unit having a capacity of 4,000 kilowatts, or a total initial capacity of 12,000 kilowatts. This plant will be enlarged as rapidly as the requirements of the railroad may demand.

The guarantees which have been made by the manufacturers of these engines are particularly interesting, electric transmission in a position to practically guarantee continuous service, regardless of the length of its transmission lines or the momentary interruptions which do occur through causes beyond human control. It might be fairly stated that the gas engine stands alone as the only means of instantaneous generation of electric current at distributing centers in times of emergency, at any fair or reasonable cost.

The gas engine electric generating plant of the California Gas & Electric Corporation will also be utilized to a certain extent for the purpose of increasing the load factor of the transmission line, for it is obvious to those familiar with power transmission plants that after proper installations have been made, including full capacity at the hydraulic end, as well as in the power-house, and in pole lines, there is absolutely no increased cost for current to the power company, whether its load factor be .2 or .99, and any device which can be utilized to improve that load factor adds that much income and net profit for the power plant. In this particular case, the gas-engine generating plant was a necessity, for without such the California Gas & Electric Coporation would have been unable to have obtained the contract for power. That being the case, the officers decided to make a virtue out of this necessity, and up to the extent of the cost of fuel being less than the increased value derived from improving the load factor on the power lines, they propose to operate this gas engine plant in that manner and for that purpose.

The gas which will be used to drive these engines will be manufactured from crude oil, and will be of the quality similar to the illuminating gas now being distributed throughout the State of California manufactured by this process, ranging from 610 to 660 B.T.U. horsepower per cubic foot.

Nearly all of the gas engines in use throughout the East and Europe are utilizing producer gas or blast furnace gases, except in very small units or where natural gas can be obtained, and from investigations which I have made I have ascertained that the largest gas engine using manufactured gas of more than 600 B. T. U. horsepower has a rated capacity of 300

* A paper read before the Thirteenth Annual Meeting of the Pacific Coast Gas Association.

horsepower, while those in process of installation near San Francisco will, in each case, be more than seventeen times as large.

The nearest approach to these large engines in size are two which are in operation at Hastings, West Virginia, each having 4500 horsepower capacity, and driven by natural gas, and being used for the compression of natural gas for transmission through a pipe line 200 miles in length. These engines have been and can be started from cold and rest to full load in less than sixty seconds.

The following is a description of these engines: These gas engines are now being built by the Snow Steam Pump Works of Buffalo, N.Y., and in general design and detail resemble very closely a modern high-grade massive American steampower engine. They are of the horizontal, twin tandem, double acting four-cycle type, giving two impulses to each crank per revolution. This is equivalent to a cross compound steam engine. Any cylinder head can be removed from any cylinder by simply disconnecting one jacket water supply pipe and removing the nuts holding the head to the cylinder.

All working parts are above the engine-room floor, nothing but water supply, gas, air inlet and exhaust pipes are below the floor, and these are arranged so that they can be trenched. All the main parts have their proper relative positions positively and permanently fixed by male and female centering fits of large diameter, thus practically insuring self-alignment.

Lubrication of the cylinders is effected by spreading. This is accomplished by leading four oil feeds, fed by individual oil pumps, to each cylinder, and entering the cylinder at points to successfully effect the proper spreading of the oil. The oil is fed to the cylinder on the inhalation stroke, and is spread on the compression stroke, thus being properly lubricated for the power or impulse stroke. The lubrication of journals is effected by means of a positive feed lubricator. Each oil feed is carried to the part to be lubricated by means of small tubing leading from a multiple feed oiler containing a small oil pump for each feed led therefrom. The feed to each part is positive and can be adjusted to give a fixed supply of oil per revolution of the engine. When the engine stops the oil feed stops, and when the engine starts the oil feed also starts. Inlet valves, mixers and cut-off valves will be designed so that gasoline can be injected to the surfaces necessary to be cleaned, rendering the dislodgment of any deposit an easy matter without removing the parts.

The pistons are carried by cross heads, thereby materially reducing the weight carried on the bore of the cylinders. By the use of three cross heads, the main, intermediate and outboard, proper alignment of the pistons is permissible after years of service, and it is questionable whether an engine without this feature can be regarded as entirely satisfactory.

The question of regulation in the generation of electric current by means of direct connected electrical generators has been a problem not only for the gas engine people but for the steam engine manufacturers to solve, and this has been done in the latter case within the last two years practically to the satisfaction of the electrical engineer, so that parallel operation is now successful. The builders of this engine are also following steam practice in this respect, and will be able to keep the angular variation within each revolution at a minimum, satisfactory to the electrical generator manufacturers.

The main shaft will be of the overhung crank type, having the cranks forged with the shaft and with crank pins forced into the cranks. The main connecting rods are simple, plain, with solid adjustable stub ends. The main cross heads are fitted with adjustable babbitted gibs and removable crucible steel wrist pins.

The pistons are designed in such a way that expansion of the faces can take place without affecting in any way the strength or life of the piston. Piston rods extend from the main cross heads clear through the cylinders to the outboard cross heads, and secured to same by nuts. Each cylinder is made in two parts, the joint being circumferential and located half way between the ends.

Separate supply pipes for each individual part to be water jacketed will be furnished, so that the amount of water fed to each part can be regulated, thus permitting the carrying of high temperatures in such parts as cylinder heads, medium temperatures in cylinder jackets, low temperatures to the rods, pistons and metallic packing.

These engines are started by the use of compressed air on storage in compression tanks. Safety devices are provided which carefully control the speed limit.

The dimensions of these engines are very interesting:

Length over all, 70 feet. Width over all, 34 feet.

Weight of heaviest casting, 60 tons.

Diameters of cylinders, 42 inches.

Length of stroke, 60 inches.

Main journals, 30 inches in diameter, 54 inches long.

Main cross head gibs, 27 inches wide, 54 inches long.

Diameter of center of shaft, 38 inches.

Weight of fly-wheel, 130,000 pounds.

Total weight of engine, fly-wheel and generator, 1,200,000 pounds.

These engines will probably be in operation on or before January 1, 1906, and from all the investigations which have been made by my co-workers, we are laboring under no doubt as to the absolute success of this installation when completed.

SPARKS.

Messrs. Hoge & Thompson, who are building a planing mill at Saskatoon, N.W.T., have applied to the Council for a franchise for electric lighting.

Weston, Ont., will continue municipal ownership of their electric light plant for some time at least. Recently the Council rejected the offers of both the Stark Telephone, Light and Power Company, of Toronto Junction, and the Southern Light & Power Company, of Erindale.

Dr. Heroult, of LaPraz, France, inventor of the electric process of ore smelting, is now at Ste. Marie, Ont., in connection with the experiments to be made by the Dominion Government. The furnace has been completed and the experiments will be under way very shortly.

Mr. E. S. Pindell, of Sault Ste. Marie, Mich., has been granted a franchise for electric light and waterworks systems at New Liskeard. The works are estimated to cost $132,000 and the town has agreed to guarantee the bonds to the amount of $80,000.

Mr. F. G. Rumball, president of the Southwestern Traction Company, last month received a cablegram from London, Eng., authorizing the company to proceed with the surveys for an electric railway from London to Hamilton, to be operated in connection with the line from London to Port Stanley. The total mileage will be about 90 miles, involving an outlay of over $2,000,000.

TELEGRAPH and TELEPHONE

WESTERN TELEPHONE EXTENSIONS.

The British Columbia Telephone Company have completed the rebuilding of their long distance line from Laurier, Wash. (on the boundary) to Greenwood, B. C. Cedar poles thirty feet long and not less than 9 inches thick at the top by 14 inches at the butt were used, 35 poles to the mile. The butts were treated with carbolineum to preserve them. The telephone wires are transposed every 1,200 feet and for about four miles, where the line is in close proximity to the Cascade Power Company's high tension line, transpositions are introduced every 600 feet. The work has been carried on under the supervision of Mr. G. C. Hodge, district superintendent. The company expect to soon move into their new building at Nelson, which has just been completed for them.

THE LAYING OF THE LATEST ATLANTIC CABLE.

The Commercial Cable Company's fifth Atlantic cable, from Canso, Nova Scotia, to Waterville, Ireland, was completed and put in operation on October 6th. This makes seven transatlantic cables worked in direct connection with the lines of the Postal Telegraph-Cable Company. All of them are duplexed, so that their combined capacity is 14 messages at one time.

The new cable is described as the best and most expensive submarine cable ever laid. It was manufactured by the Telegraph Construction and Maintenance Company, of London, having been begun in March, 1905, and finished and shipped on board the construction company's steamer Colonia on August 3rd, 1905.

Atlantic cables are always laid from west to east, because the prevailing winds in the summer months on the Atlantic are from the west, and ships meet much better weather going eastward; consequently the Colonia sailed directly from England to America, arriving off the coast of Nova Scotia on August 16th, and landed the heavy shore end of the cable on the morning of August 18th. Moving out from the shore it struck a rock and remained fast thereon for four days. The injuries it sustained compelled it to go into drydock at Halifax with 2,300 miles of submarine cable aboard. It was the largest and heaviest ship ever taken on that drydock, exceeding by thousands of tons the United States battleship Indiana of 10,000 tons, which went into drydock there a couple of years ago. Repairs were made, and the Colonia took the sea again.

On September 23rd the ship laid its course from Canso, N. S., paying out cable. On September 28th it passed through a hurricane in mid-Atlantic, although on that day the weather on both sides of the Atlantic was reported fine, with gentle winds. On October 3rd it arrived without a mishap at a point 187 miles from the coast of Ireland, where a final splice was to be made between the cable that had been paid out from the American side and the 187 miles of cable previously laid westward from the Irish coast by the steamship Cambria in the month of June. The weather was heavy and the Colonia was compelled to heave to for several days awaiting smoother seas to enable it to make the final splice, which was made on October 6th.

At some points the cable was laid at a depth of nearly three miles below the surface of the sea. The quantities used in the manufacture of the cable were 1,411,200 pounds of copper; 799,688 pounds of gutta-percha; 1,500,000 pounds of brass tape, jute yarn, iron wire and preservative compound.

The signaling speed of this cable is reported to be 15 per cent. greater than that of any other cable of equal length in the Atlantic. The cost of the cable varied from $1,000 to $6,000 per mile, according to the character of the ocean bed and depth of water, the great variation in cost being due to the different diameters and weights of the sections of the cable, the cable which is laid in the deepest water being lightest for the important reason that it would be impossible to retrieve a heavy cable from the deep water, because of the enormous pressure. Cable in deep water is practically safe from injury, and therefore does not need to be so strong, so that the sections laid in the deepest water are of smaller diameter and lesser cost. The sections laid near shores are of massive construction and very expensive. In the neighborhood of the fishing grounds off the coast of Newfoundland a type of cable midway between the deep water and shore-end cable is used. The intermediate size is made strong, to resist injuries from the anchors of fishing craft, the most prolific source of danger to submarine cables. This intermediate type is made just heavy enough to afford reasonable prospect of retriving it in the event of its being damaged by the anchor of a fishing vessel.

SHORT-CIRCUITS.

The Winnipeg Board of Trade have decided to agitate for the installation of a municipal telephone system.

A by-law was carried at Port Arthur, Ont., last month providing $18,000 for the extension of the municipal telephone system and central station.

The Bell Telephone Company are arranging to install a telephone system at shoal Lake, Man., to have connection with the long distance service by Hamiota.

Mr. W. J. Duckworth, formerly inspector of the G. N. W. Telegraph Company, has been appointed superintendent of maintenance for the same company.

Mr. F. R. Carney, Ottawa manager of the G. N. W. Telegraph Company, has been promoted to the management of the Montreal office. His successor at Ottawa is Mr. J. G. Davies.

The New Brunswick Telephone Company are making improvements to their exchange at Moncton, N. B. A two storey brick building has been erected and is being thoroughly equipped with modern appliances. The switchboards were obtained from the Kellogg Switchboard Supply Company, of Chicago. Mr. George C. Peters is the local manager at Moncton.

Mr. W. B. Powell, for many years Montreal manager of the Great North-Western Telegraph Company, severed his connection with the company last month, after thirty-seven years' service. He resigned to enter a business life. Previous to his departure he was presented with a beautiful diamond pin as a token of esteem and good will from the staff, including the branch office employees. The presentation was made by Mr. James Tucker. Mr. Powell, in acknowledging the gift, stated that he would prize it very highly as coming from those with whom he had been associated for so many years.

Mr. Beauchamp H. Smith, second vice-president of the S. Morgan Smith Company, of York, Penna, died at his home in Los Angeles on November 1st, at the age of 36 years. Mr. Smith went to Los Angeles about five years ago for the benefit of his health, since which time he has resided there, and hopes of a complete recovery were entertained.

THE REGINA ELECTRIC LIGHT PLANT.

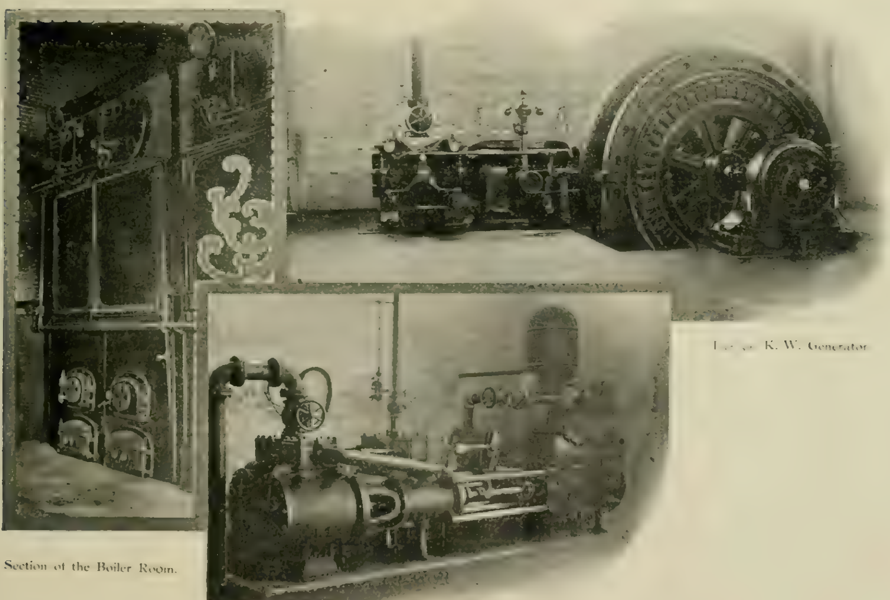
The City of Regina, Saskatchewan, has recently completed modern sewerage, waterworks and electric light systems, from the plans of Mr. John Galt, C. E., of Toronto. The water supply is obtained by gravitation, and by means of the construction of a concrete dam about seven miles from the city, a reservoir with a capacity of 80,000,000 gallons has been formed.

The waterworks and electric light power house is a substantial brick building measuring 70 by 68 feet and situated on the northern outskirts of the city. It is divided into three sections—boiler room, pump room and electric light room. In the boiler room are installed two 250 h.p. Babcock & Wilcox water-tube boilers of the latest design, carrying all the most recent improvements in the water-tube boilers made by that well-known Glasgow firm. The pump room contains the Northey pump, used for increasing the pressure of the water system in the event of fire.

The electric lighting plant consists of a 475 h.p. simple Corliss engine shpplied by the John Inglis Company, of Toronto, connected to a 300 kilowatt generator, manufactured by the Canadian Westinghouse Company and capable of supplying 7,000 16 candle power lights. The lighting system is under the management of Mr. J. A. Johnston, electrical engineer, and is rapidly being extended in all parts of the city. The plant also supplies the current for the 35 arc lamps which make Regina one of the best lighted cities west of Winnipeg.

Waterworks and Electric Light Power House, Regina, Sask.

Mr. J. A. Johnston, Superintendent.



[illegible] K. W. Generator

Section of the Boiler Room.

Steam Pump for Fire Pressure

Interior Views, Waterworks and Electric Light Power House, Regina, Sask.

ENGINEERING and MECHANICS

BOILER INSPECTION IN ONTARIO.

Mr. James T. Burke, Inspector of Factories for Ontario, in his annual report to the Minister of Agriculture, refers at some length to boiler inspection. He says:

Preliminary to a boiler inspection, the boiler, flues, mud-drum, ashpit, and all connections should be thoroughly cleaned, to facilitate a careful examination. Blisters may occur in the best iron or steel, and their presence, and also that of thin places, is ascertained by going over all parts of the boiler with a hammer. When blisters are discovered, the plates should be repaired or replaced. Repairing a blister consists in cutting out the blistered space and riveting a "hard patch" over the hole on the inside of the boiler, if possible, to avoid forming a pocket for sediment. All seams, heads, and tube ends should be examined for leaks, cracks, corrosions, pitting and grooving, detection of the latter possibly requiring the use of a magnifying glass. Uniform corrosion is a wasting away of the plates, and its depth can be determined only by drilling through the plate and measuring the thickn ss, afterwards plugging the hole. Pitting is due to a local chemical action, and is readily perceived. Grooving is usually due to buckling of the plates when under pressure, and frequently to the careless use of the sharp calking tool. Seam leaks are generally caused by overheating, and demand careful examination, as there may be cracks under the rivet heads. If such cracks are di covered, the seam should be cut out, and a patch rivetted on. Loose rivets should be carefully looked for, and should be cut out and replaced, if found. Pockets, or bulging, and burns should be looked for in the firebox. The former are not necessarily dangerous, but if there are indications of their increasing, they should be heated and forced back into place or cut out and a patch put on. Burns are due to low water, the presence of scales, or to the continuous action of flames formed on account of air leaking through the brickwork. The burned spots should be cut out and patched as previously described. The conditions of all stays, braces, and their fastenings should be examined, and defective ones replaced. The shell of the boiler should be thoroughly examined externally for evidences of corrosion, which is liable to set in on account of dampness, exposure to weather, leakage, etc., and may be serious. The boiler should be so set that joints and seams are accessible for inspection and should have as little brickwork in contact with it as possible. The brickwork should be in good condition, and not have air holes in it, since they decrease the efficiency of the boiler and are liable to cause injury to the plates by burning, as above explained, and also by unevenly heating and distorting them. The mud-drum and its connections are liable to corrosion, pitting and grooving, and should be examined as carefully as the boiler.

All valves about a boiler should be easy of access, and should be kept clean and working freely. Each boiler should have at least three gauge cocks, properly located, and it is of the utmost importance that they be kept clean and in good order, and the same may be said of the glass water gauge. The middle gauge cock should be at the water level of the boiler, and the other two should be placed one above and one below it, at a distance of about 6 inches.

The conditions of the pumps or injectors should be looked into, to make sure that they are in the best working order. The steam gauge should be tested to ascertain that it indicates correctly, and if it does not it should be corrected. If the hydraulic test is to be used, the boiler should be tested to a pressure of 50 per cent. higher than that at which the safety valve will be set.

EXTERNAL INSPECTION WHEN BOILER IS UNDER STEAM.

The gauge cocks, and also the gauge glass, should be tried, to make sure that they are not choked. The steam gauge should be taken down, if permissible, and tested, and corrected, if necessary. The gauge pointer should move freely. Blowing out the gauge connection will show whether it is clear or not. The boiler connections should be examined for leaks. The safety valve should be lifted from its seat, to make sure that it does not stick from any cause, and it should be seen that the weight is in the right place. Observe from the steam gauge if the valve blows off at the pressure it is set for. See that all pumps and feed apparatus are working properly, and that the blow-off and check valves are in good order. Blisters and bagging may sometimes be detected in the furnace. The condition of the brickwork is of considerable importance, since the existing of air-holes is a source of trouble, as already explained.

Incrustation. One of the chief sources of trouble to the boiler user is that of incrustation. All water is more or less impure; and as the water in the boiler is continuously evaporated, the impurities are left behind as powder or sediment. This collects on the plates forming a scaly deposit, varying in nature from a spongy, friable texture to a hard, stony one. This deposit impedes the transmission of heat from the plates to the water and often causes overheating and injury to the plates. The various impurities in the water may be either in suspension or solution. If the former, the water can be purified by filtration before going into the boiler. If the latter, the substances must be first pr. cipitated and then filtered. Many impurities may be removed by heating the water before feeding it into the boiler. The first thing to do, when dealing with a water supply, is to have an analysis of it made by a competent chemist. The fact that water contains a certain amount of solid matter is no criterion as to its unfitness for boiler use. The presence of certain salts, as carbonate or chloride of sodium, even in large quantities, would not be serious if due attention were given to the blowing off. On the other hand, salts of lime in the above proportion would be very objectionable, requiring greatly increased attention in the matter of purification and blowing off or else cleansing out.

The various methods of dealing with impure water may be classed as follows:

1. Filtration. Where the matter is held in suspension, it can be removed, before the water enters the boiler, by the aid of settling tanks or by filtering, or by forcing the water up through layers of sand, broken brick, etc., or by using filtering cloths in a proper machine.

2. Chemical Treatment. Clark's process combined with a frequent filtration (the joint process being known as the Atkins system), has been successfully applied on small and large scales in the chalk districts of England. Lime water is mixed with the water to be purified, the amount used depending on the composition of the water as determined by a careful analysis. The lime is thus precipitated, and the water is then filtered in a machine containing travelling cotton cloths. Not only is the carbonate of lime entirely removed, but it has been proved that any sulphate of lime that may be present is also prevented from incrusting. This is important, as the latter impurity forms, perhaps, the worst scale one has to contend with.

Various chemical compounds are in use for boilers. Carbonate of soda is perhaps the best general remedy. It forms the basis, in fact, of nearly all boiler compounds, whatever their name or appearance. This soda deals efficaciously both with the carbonate and the sulphate of lime. The precipitates thus thrown down do not form a hard crust; they can be washed out in the form of a sludge or mud.

Carbonate of soda is also useful where condensers are employed, as it counteracts the effect of the grease, which is brought over with the exhaust steam. If used in too large quantities, it will cause priming. The best way to use it is to make a solution of it and connect with the feed, fixing a cock so as to regulate the amount fed in. Soda ashes is much cheaper, but more of it is required, and, besides, it is generally impure. Caustic soda removes lime scale quicker than ordinary soda does, but it is much stronger and liable to attack the plates. It should be used in smaller quantities than the ordinary kind.

Barks, molasses, vinegar, etc., develop acids that attack the plates. Animal and vegetable oils do the same, and also harden the deposits, and make their removal more difficult. It is a good rule to keep all animal and vegetable matter out of boilers altogether.

Feed-Water Heaters. Carbonates and sulphates of lime are precipitated by high temperatures. The heaters should be arranged so that the deposit forms chiefly on a series of plates

that can be easily removed for cleaning. If the deposit gathers in pipes, however, it is simply transferring the evil from one vessel to another. A double advantage is gained by these heaters, for the feed water is put into the boiler already heated, and so fuel is saved.

MECHANICAL AIDS. Deposits take place chiefly in sluggish places. Various devices to aid circulation have been brought out. With good attention and a not too impure water, they give satisfactory results.

Potatoes, linseed oil, molasses, etc., are sometimes put into the boiler with the idea of lessening scale formation, by forming a kind of coating around the particles of solid matter and so preventing their adhering together. This certainly takes place, but the substances are injurious, as already pointed out. Whenever a boiler has been cleaned out, we may with advantage give the inside a thin coating of oil, or tallow and black lead; this arrests the incrustation to a great extent.

Sand, sawdust, etc., are often used, the idea being that their grains act as centres for the gathering together of the solid matter in the water, the resulting small masses not readily collecting together themselves being easily washed out. This may be so, but the cocks, valves, etc., are liable to suffer from the practice.

Kerosene is strongly recommended by some boiler users. There is no doubt that in many cases its use has given good results. It prevents incrustation, by coating the particles of matter with a thin covering of oil, the deposit thus formed being easily blown out. The oil also seems to act on the scale already formed, breaking it up and thus facilitating its removal. As already remarked, it is a good plan, when the boiler is empty, to give the inside a good coating of this oil, afterward putting it in with the feed, the supply being regulated automatically. As to the quantity required, this will be found to vary in different cases, according to the nature of the water; an average of one quart per day for every 100 horse power will give good results in most cases.

In marine boilers, strips of zinc are often suspended; the deposit often settled on them instead of on the boiler plates. Also, any scale that way be formed on the latter is less hard and compact and more easily broken up. Further, any acids formed by the oil and grease brought over from the condenser attack this zinc instead of the boiler plates.

MISCELLANEOUS. Acids are often introduced into boilers to dissolve the scale already formed, the solid matter then being washed out. This treatment should be adopted with great care if at all, as the plates are likely to be affected.

Scale is often loosened and broken up by deliberately inducing sudden expansion or contraction in the boiler. In the former case, the expansion is brought about by blowing off the boiler, and then, when it is quite cooled down, turning on steam at as high a temperature as obtainable, thus causing the scale to expand more quickly than the plates and thus become loose.

In the second method, the boiler is blown off when the steam is at its highest, and a stream of cold water is then turned in. The fires are then drawn, and the fire-hole doors, dampers, etc., opened, letting in a rush of cold air. All this cools the plates, and, by the contraction thus brought about, loosens the scale. These two practices should be guarded against.

Foaming or priming is usually due either to forcing a boiler beyond its capacity for furnishing dry steam, or to the presence of foreign matter. It is dangerous if occurring to any great extent, since water may be carried along with steam into the engine, and a cylinder head knocked out. Foaming when it cannot be checked by the use of the surface blow-out apparatus, may necessitate the emptying of the boiler, which must then be filled with fresh water; this rids the boiler of the impurities that have collected during the operation of the boiler.

The Fox Bearings, Limited, has been incorporated at Toronto, with a capital of $40,000. It is proposed to acquire the patents for anti-friction bearings owned by Tobias Fox. The directors include Thomas Sullivan and John Nicol, of Pine Glove, Ont.

The Pembroke Electric Light Company have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal, in connection with the development of their water power on the Black river. The transmission will be fifteen miles. The ultimate development will be for 4,000 horse power; the present installation will consist of one-half the total capacity.

TORONTO ENGINEERS' DINNER.

Toronto No. 1, C.A.S.E., celebrated their nineteenth annual banquet at the Walker House on Thanksgiving Eve, October 25th. It was, as usual, a most enjoyable affair. Covers were laid for 150 guests and every place was occupied. After the abundant repast provided by the genial host, Mr. Thomas M. Bayne, had been partaken of, there was a splendid programme of speech and song. Mr. W. C. McGhie, President of Toronto No. 1, acted as toast-master and discharged his duties in a most acceptable manner. The singing of the National Anthem was the appropriate response to the toast of "His Majesty the King." The respondents to the other toasts were as follows: "Canada Our Home," by Ald. J. H. McGhie; "Our Legislature," by Dr. Beattie Nesbitt, M.P.P., and Ald. S. Alfred Jones; "Educational Interests," by Dr. Pakenham and W. S. Kirkland, of the Technical School, and Mr. Harry Simpson, of the Board of Education; "Manufacturing Interests," by Mr. J. J. Main, of the Canadian Heine Boiler Company, Mr. W. J. Murray, of the Chapman Double Ball Bearing Company, and Mr. J. Litster, of the Pure Gold Manufacturing Company; "The Executive Council," by Messrs. W. A. Sweet, of Hamilton, Charles Moseley and A. M. Wickens; "Sister Societies," by Messrs. J. Ironsides, Hamilton, and J. Fox, Toronto; "The Press," by Messrs. S. Groves, of the Canadian Engineer, A. Bridle, of the Engineering Journal, and T. S. Young, of the CANADIAN ELECTRICAL NEWS; "Toronto No. 1," by Mr. W. McGhie.

Songs were rendered during the evening by Messrs. Medcalf, Wilson, Day and Fletcher. The committee in charge of the arrangements was H. E. Terry (chairman,) W. Tait, (secretary-treasurer), J. W. Marr, G. C. Mooring, Alex. Storer, William Corrigan, William Outhwaite, Charles Birrell and Joseph Hughes. These gentlemen were heartily congratulated on the success which attended their efforts.

GAS ENGINE DRIVEN SINGLE PHASE RAILWAY SYSTEM.

The Westinghouse interests announce the successful starting of the Warren & Jamestown alternating current railway system operating between Warren, Pa., and Jamestown, N. Y. The electrical equipment has had several weeks' preliminary run from a small gas engine driven unit temporarily installed in the power house at Stoneham. On the 19th ultimo the large gas engines were placed in service for the first time and a permanent operating schedule was inaugurated.

Probably the most interesting feature of this rather unique railway system is the exclusive employment of horizontal double acting gas engines of the heavy duty type for the generation of power to operate the road. Two of these engines are now installed, the first of which is already operating. The second will be placed in service in a short time. These two engines will be called upon to operate in parallel on the electrical end. Parallel operation is particularly difficult in service of this kind on account of the violent fluctuations in load which occur, due to the size of the cars employed and the small number in operation at any particular time. As it is not possible to utilize storage batteries to absorb these fluctuations, the engines are called upon to sustain them and are thus put to the severest possible test occurring in the operation of electric power plants.

The two units installed are each of approximately 500 b. h. p. capacity direct connected to 260 kw. revolving field engine type single phase generators. Each has two cylinders arranged in tandem fashion with a single crank. They will operate entirely upon natural gas distributed by a local company. In this district the gas has a calorific value of 1,000 b.t.u. per cu. ft. A 55 h.p. vertical Westinghouse engine of the single acting type is also in operation driving air compressor and exciting unit for the main equipment.

Current is generated directly at a voltage suitable for transmission without the use of transformers. Transformer substations are located along the right of way which reduce the line voltage to 3,300 volts for the trolley, at which pressure it is collected by the cars.

The Warren & Jamestown Street Railway, although recently organized upon its present basis, has been running part of its present line for eleven years. Three years ago it began experimenting with gas power with sufficient success to induce the use of gas engines for the entire power generation. The successful starting of the power system will be accepted with general gratification, and will mark an important advance in modern electric railroading.

PERSONAL.

Mr. John Bell, of Winnipeg, has been appointed electrician for the corporation of Indian Head, N.W.T.

The School of Practical Science have awarded a fellowship in electrical engineering to Mr. R. H. Armour.

Mr. C. B. King, of Detroit, has been offered and accepted the management of the London Street Railway Company, London, Ont., as successor to Mr. C. E. A. Carr.

Mr. Zavitz, late of the Toronto office of Allis-Chalmers-Bullock, has been placed in charge of their Vancouver office. Mr. Murphy, of the Winnipeg office, who has been temporarily in charge at Vancouver, has returned to the Prairie Capital.

Mr. A. Bruce Smith, recently appointed manager or telegraphs for the Grand Trunk Pacific Railway, entered upon his new position on November 1st. Before leaving Toronto he was presented with a handsome solid silver tea service by his old friends of the G.N.W. Telegraph Company.

Mr. Angus MacDonald has been appointed chief electrician in charge of the electrical equipment of the LeRoi Mines at Rossland, B.C., to succeed Mr. S. F. Crawford, who has removed to Korea. Mr. MacDonald was formerly with the electrical department of the Canadian Smelting Works at Trail, B.C.

Mr. Seth B. Smith, formerly with the Westinghouse Electric and Manufacturing Company, Pittsburg, in charge of their Los Angeles, Cal., branch, has been placed in charge of the Canadian Westinghouse Company's Vancouver branch. Mr. Smith has had a wide and varied experience in matters electrical during the past twenty years, a large part of which time has been spent with the Westinghouse Company.

Mr. S. F. Crawford, for the past three years chief electrician of the LeRoi Mines at Rossland, B. C., has been appointed chief electrician in charge of the electrical plant of the Oriental Consolidated Mining Company, of Korea. Mr. Crawford was formerly with the Jones & Moore Electric Company and the United Electric Company, both of Toronto. He is now in Toronto bidding adieu to old friends and expects to sail from Vancouver early in December. The mines to which he is going are located in the Yalu River within 40 miles of Port Arthur. A 6,000 h.p. electric plant has been installed for mining purposes, the product being gold and copper ore. The ELECTRICAL NEWS wishes Mr. Crawford success in his new field of labor.

Major Joly de Lotbiniere, son of Sir Henri Joly de Lotbiniere, Lie tenant-Governor of British Columbia, recently returned to England after a visit to Canada. Major Joly is noted as one of the foremost English civil and electrical engineers. He has planned and surpervised the installation of a number of large electrical plants and irrigation systems, a commission which he is now executing being an immense irrigation and power scheme which is being carried out by the Indian Government near Kashmir. Four large rivers are being dammed and a huge lake formed to store water which will irrigate over ten thousand acres of splendid rice lands. This stored water will also be utilized to generate over 100,000 horse power in electrical energy, which will be used as power for rice and flour mills and other purposes. Major Joly inspected nearly all the large water power plants on the Pacific coast, including that of the Vancouver Power Company.

The corporation of Fraserville, Que., recently purchased an electric light plant. Mr. John Hogg, electrical engineer, is now engaged in putting the system in first-class condition.

Application will be made to Parliament at its next session to incorporate the Buffalo, Niagara and Toronto Railway Company, with power to construct an electric railroad from Niagara-on-the-Lake to St. Catharines and Port Colborne, and touching Fort Erie.

The Town Council of Ingersoll, Ont., at a meeting held on October 17th, decided to enter into a new contract for street lighting with the Ingersoll Electric Light and Power Company, the latter to supply ten arc lamps of 2,000 candle power all night for 300 nights a year for $1,000. Mayor Boles has refused to sign the contract, to which there is much opposition owing to the fact that 25 arc lights have been cut off under the new arrangement. Since the original tenders were opened, the Electric Light Company have offered to furnish an all-night service with 45 arc lights for $2,500 per year, the present contract price for 37 arcs, of which only ten burn all night.

PUBLICATIONS.

Kindly mention the CANADIAN ELECTRICAL NEWS when writing for any of the catalogues referred to below.

The latest bulletin from the National Electric Company, Milwaukee, Wis., relates to their new belt-driven alternating current generators.

We have been favored with a copy of the charter of the Niagara-Welland Power Company as amended to 1905, with a chronological table of events. The president of this company is Mr. Harry Symons, K.C., Toronto.

The Mines Branch of the Department of Interior, Ottawa, have issued a very valuable report on "Mica, Its Occurrence, Exploitation and Uses," the author being Mr. Fritz Cirkel, M.E., of Montreal. The book consists of 150 pages and is profusely illustrated.

Engine Bulletin No. 3, issued last month by the Goldie & McCulloch Company, Galt, Ont., describes their heavy duty Corliss engine. One of the illustrations is a 17 x 30 inch Goldie Corliss engine direct connected to a 150 k.w. alternating current generator installed for the corporation of East Toronto.

The Westinghouse Companies' Publishing Department have compiled a small folder for the storage battery department of the Westinghouse Machine Company. It is entitled "Westinghouse Storage Batteries for Railway Service" and serves as an announcement of this new and important branch of their business.

"Westinghouse Railway Apparatus" is the title of an attractive booklet which came to hand last month from the Canadian Westinghouse Company, Hamilton, Ont. It illustrates and describes their direct current railway motors, single phase alternating current motors, Baldwin-Westinghouse electric locomotives and the Westinghouse systems of control.

A neat booklet from the Industrial Engineering Company of America, 32 Broadway, New York, calls attention to their facilities for assisting manufacturers. They are specialists in designing electric motors, individual electric driving of machinery and tools, and furnish complete drawings and specifications for power and manufacturing plants of every description.

Managers and operators of electric plants will find much information regarding rotary converters in a book of 70 pages recently issued by the Westinghouse Electric & Manufacturing Company, of Pittsburg. Instructions are given for starting a single converter with a starting motor and from direct current side, and to start a second converter to run in parellel with another, also what to do when the circuit breaker comes out.

The Pittsburgh Transformer Company have published a book on "Thawing Frozen Water Pipes by Electricity." In this book are a large number of letters from the managers of various electric light plants and waterworks which used the standard thawing outfit that the Pittsburgh Transformer Company placed upon the market last winter. The Pittsburgh Transformer Company state that in addition to the large number of thawing outfits which they shipped to all parts of the country by freight last winter, they also shipped approximately twenty tons of thawers by express. A number of purchasers delayed placing their orders until late in the season, thus rendering express shipping necessary, with its attendant high charges. The company recommend that this year orders be placed in good season so that freight shipments can be made, thus saving considerable expense.

At a meeting of the board of directors of the American Institute of Electrical Engineers held September 26, 1902, a resolution was passed appointing a committee of five members for the purpose of collecting data respecting present practise in electric transmission at high voltage and to present a report which would indicate the successful methods which are now in operation in such form as to be of immediate value to electrical engineers. The information gathered by this committee was given to the members in a series of papers presented at the meetings of the Institute. These, with the subsequent discussions thereon, have been published in book form by the McGraw Publishing Company, of New York, under the title of "High Tension Power Transmission," the contributors to which are Ralph D. Mershon, F. O. Blackwell, P. M. Lincoln, C. C. Chesney, C. L. Cory and A. M. Hunt. The price of the book is $3.

The dissolution is announced of W. J. O'Leary & Company electrical contractors, Montreal.

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VOL. XVI. FEBRUARY, 1906 NO. 2.

Single-Phase Electrical Equipment for the Sarnia Tunnel

An arrangement has been made between the St. Clair Tunnel Company and the Westinghouse Electric & Manufacturing Company for a complete electrical installation to operate freight and passenger trains through the tunnel which connects the American and Canadian divisions of the Grand Trunk Railway System. The equipment of this line constitutes another victory for the single-phase alternating current in heavy transportation service and evidences the growing favor with which this system is regarded by progressive engineers.

The plans and specifications were prepared by Mr. Bion J. Arnold, of Chicago, whose pioneer work in single-phase alternating-current traction is known to all engineers. The work of installation will be conducted under Mr. Arnold's supervision.

The proposed equipment includes a complete power station containing boilers, stokers, coal and ash handling machinery, feed pumps, feed water heaters, condensers, water supply, fire protection and heating systems, piping, electric crane, steam turbine generating units, engine driven exciting unit, motor driven exciting unit, switchboard, feeder and distributing system, bridge and pole lines for catenary trolley construction, overhead work, bonding, transformers for power and light, light and power distributing systems, lightning protective apparatus, arc and incandescent lamps, round house motors, motor driven pumps, drainage and sewer systems for buildings and yards, and electric locomotives.

There are to be six similar units designed to meet the requirements of the tunnel service of the Grand Trunk Railway. The power equipment of each unit comprises three 250 h.p. single-phase, series-wound motors of the same general type as those recently adopted by the New York, New Haven & Hartford Railway for their terminal operations in New York. Pneumatically operated trolleys of the pantagraph type will collect the current from the overhead trolley line outside the tunnel.

The Sarnia tunnel of the St. Clair Tunnel Company passes under the St. Clair river and connects the divisions of the Grand Trunk Railway System which terminate at Port Huron, Mich., and Sarnia, Ont. The tunnel proper is 6032 feet long. A single track leads through the tunnel, but the approaches are double track up to a point about 300 feet from each portal. From terminal to terminal, a distance of 19,347 feet will be electrically equipped.

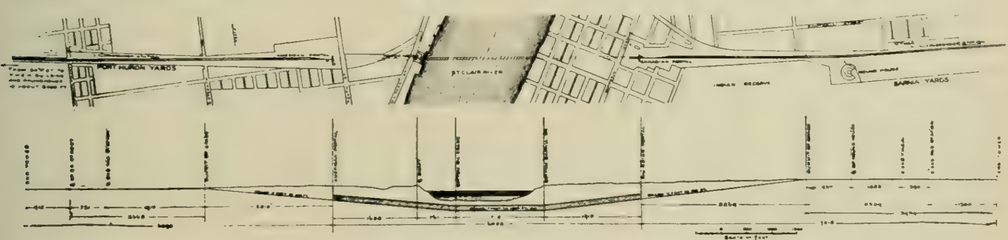

FIG. 1.—MAP AND PROFILE OF ST. CLAIR TUNNEL.

At the present time passenger and freight trains arriving from either direction are hauled through the tunnel by steam locomotives. Almost all of the freight trains must on arrival be divided, as they are too heavy for a single locomotive. The result has been that traffic is congested at the terminals and the entire service of the system impaired. It is expected that the electric locomotives will greatly relieve this congestion, as their greater capacity and flexibility will eliminate or largely reduce the necessity of dividing trains.

Alternating current at 3,000 volts, 25 cycles, will be delivered to the locomotives. Outside the tunnel the current will be fed through a No. 0000 grooved trolley wire and pantagraph trolley to the locomotive equipment. The trolley wire will be hung by a catenary suspension from steel towers which span the track or from bracket arms mounted on lattice work poles of steel.

Tunnel operations are conspicuous fields for the electrical propulsion of heavy trains and the applica-

tion of the single-phase alternating-current system to the St. Clair problem provides a most effective solution of the difficulties encountered. By its adoption the Tunnel Company is enabled to utilize the safe and simple catenary line construction rather than the dangerous third rail, to eliminate electrolytic troubles of every kind, and to secure a close and efficient speed

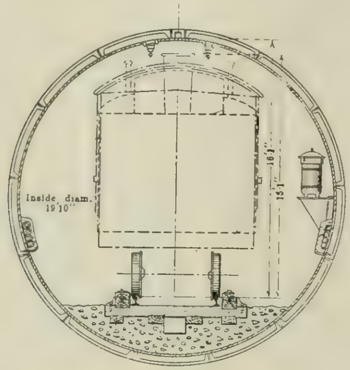

Fig. 2.—Cross-Sectional View of Tunnel.

control with economical starting and rapid acceleration. The system may be readily applied to more extensive operations, is suitable for light and general power as well as for railway service, and is more cheaply installed and more economically operated than any other electrical method so far devised.

THE ELECTRIC LOCOMOTIVES.

The single-phase electric locomotives to be adopted will weigh approximately 62 tons and will develop a draw-bar pull of 25,000 pounds on a 2 per cent. grade at a speed of 10 miles per hour. It is of the rigid frame type with driving axle boxes held in the same frame that contains the draft gear. It will be mounted on three pairs of driving wheels which will sustain the entire weight, distributed by equalizer bars similar to those used in steam locomotive practice, will have an outside frame supported on semi-elliptical springs, and will be equipped with Westinghouse friction draft gear, M.C.R. automatic couplings, air sanding apparatus, and bumper steps, front and back. The cab will be of sheet metal mounted on a framework of iron which supports both walls and roof.

The principal dimensions will be as follows: Length over end sills, 27 ft. 9 in.; rigid wheel base, 12 ft.; width over all, 9 ft. 6 in.; height from top of rail to top of cab, 12 ft. 6 in.; diameter of driving wheels, 62 in.

The operating apparatus will be arranged along the sides of the cab, leaving a free passage-way 3½ feet wide the entire length. The cab will be lighted and heated by electricity, arrangement being made to screen the instrument lights while the locomotive is running.

Westinghouse combination automatic and straight air and American driver brakes will be used. The air supply will be provided by a two-cylinder motor-driven air compressor having, with a 5-inch stroke and speed of 190 r. p. m., a capacity of 45 cubic feet of air per minute. Air reservoirs, signal outfits, whistle, bell with pneumatic ringers, automatic pump governor, tools, instruments, gauges, headlights, push poles and other details complete the auxiliary equipment.

A motor will be geared to each axle, giving each unit an aggregate rated capacity of 750 h.p. They are of the Westinghouse single-phase alternating-current, series-wound, compensating type, whose successful development was first publicly announced in the notable paper read by Mr. B. G. Lamme before the American Institute of Electrical Engineers in New York, Sept. 26, 1902. They are of the same general character as the motors selected by the New York, New Haven & Hartford Railroad Company for the operation of their line between New Haven and New York. Each motor will weigh complete approximately 14,500 pounds, the armature weighing approximately 5,600 pounds.

The motor frame consists of a steel cylinder cast in one piece and enclosed at the end by brackets of the same material, which carry the bearings and oil reservoirs. The suspension noses and safety lugs form a part of the main casting. Seats for the axle bearings are cast solid with the frame. All bearings are of phosphor-bronze lined with babbitt and are divided into two parts. They are of exceptionally large dimensions, are arranged for oil waste lubrication, and are provided with large openings on the low pressure side, giving a thorough lubrication to the entire bearing surface. Oil is fed into the reservoirs through

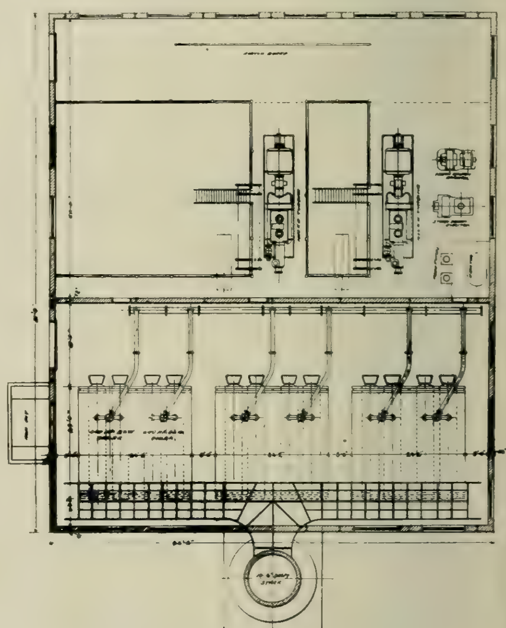

Fig. 3.—General Plan of Power House.

openings separate from the waste pockets and therefore reaches the waste from below and is thoroughly filtered before entering the bearing.

The motors are swung between the locomotive frame and the driving axles by a flexible nose suspension from two hangers supported by a truck transom and passing through heavy lugs with helical springs above and below the lug. The motors are held to the axle by means of caps which are split at an angle of 35 deg. with the perpendicular, so that the greater part of the weight is borne by solid projections from

the motor frame which extend over the axle rather than by the cap bolts. Large openings above and below provide access to the commutator and brush holders.

Within the cylinder of the motor frame there is built up a core of soft steel punchings, forming a complete laminated field. The punchings are dovetailed into the frame and clamped between end rings of cast steel. The field coils are wound with copper strap insulated between turns and about the coils by mica and finished by taping and dipping, and are impregnated in the best grade of varnishes, providing a sealed coil which can withstand the most severe internal heat and is practically indestructible under the usual conditions of heavy railway service.

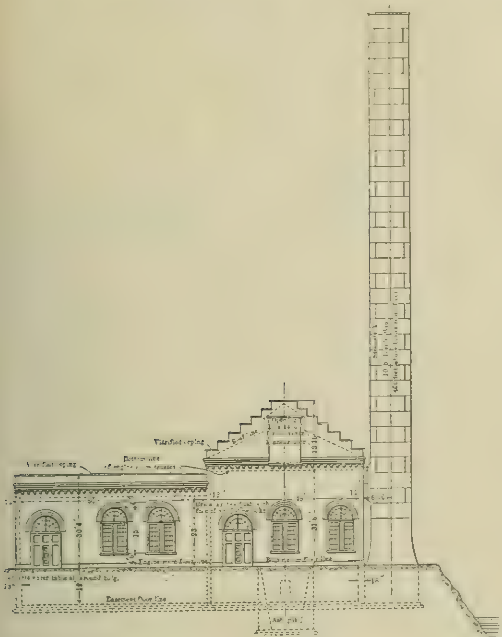

FIG. 4.—END ELEVATION OF PROPOSED POWER HOUSE.

In addition to the main coils the field carries a neutralizing winding which consists of copper bars placed in slots in the pole faces and joined at the ends by connectors of copper strap, so as to form one continuous winding which is connected in series with the main field winding and with the armature circuit. The magnetizing effect of this auxiliary winding is directly opposite to and neutralizes that of the armature winding, thus eliminating the effect of armature re-action and improving commutation and power factor. The main coils can be easily removed without disturbing the auxiliary winding.

The armature cores are formed of slotted soft steel punchings built up upon a spider and keyed in place. The spider is forced upon the shaft with heavy pressure and secured by a steel key. Coils of copper strap are embedded in the slots and joined to form a closed multi-circuit winding which is cross-connected, like the multi-circuit winding of a direct-current generator. The basis of the insulation is mica. A preventive winding is connected between the commutator and main coils, introducing a preventive action which is effective only when the coil is passing under the brush.

During operation a forced circulation of air supplied by motor-driven blowers enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation of both motors and auxiliary apparatus forms one of the most interesting innovations in electric railway construction. It secures a maximum output from a given weight of material, and a high ratio of continuous output to the one-hour meter rating common in railway practice. It also prevents effective ventilation while the locomotive is not in operation, as the blower may be driven while the locomotive is standing at the station or at the end of the line. Motors ventilated in this manner are enclosed and are thereby protected from internal damage by dirt and water and from mechanical injury.

These motors are wound for 240 volts and 25 cycles per second and have a nominal rating of 250 h.p. each, on the basis of usual electric railway practice.

SYSTEM OF CONTROL.

The essential elements of the control equipment include the collecting devices, the auto-transformers, the unit switches, the preventive coils, the reverser and master controllers. A multi-unit system of control is provided with pneumatically operated switches and circuit breakers, low voltage control circuit, and other characteristics standard in Westinghouse practice. Any unit may be controlled from either end, and two or more units may be coupled together and operated from a single cab and by a single crew. The tractive effort which can be readily applied to a single train is therefore limited only by the number of units available, and the hauling power is limited only by the mechanical strength of the coupling between locomotive and cars. A control circuit is carried from one unit to the next by means of connecting sockets and jumpers in the usual manner.

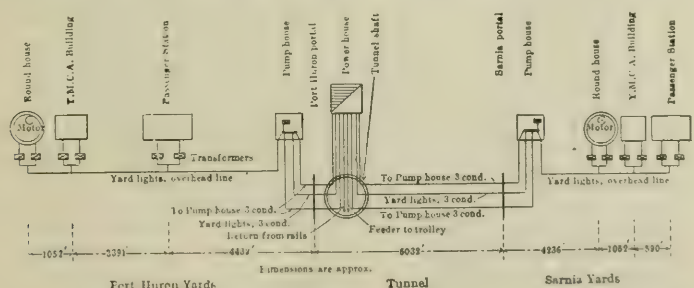

FIG. 5.—DIAGRAM OF FEEDER SYSTEM, ST. CLAIR TUNNEL AND YARDS.

Speed control of the driving motors is secured by variation of the voltage at the motors obtained by means of taps taken from the winding of the auto-transformer which receives current from the trolley at 3000 volts and reduces it to 240 volts or lower, according to the tap employed. These taps are connected to unit switches from which current is led through the preventive coils to the motors. Four unit switches serve to reverse the field of each motor.

The unit switches are of standard Westinghouse design and are, in effect, pneumatically operated circuit breakers of great power and reliability. The mechanism is such that a rolling and sliding contact is obtained when the switch closes and opens. The arc is broken at the taps, leaving the contact surfaces smooth and unscarred. Each unit has a magnetic blow-out coil with laminated core. The switch cylinders are controlled by magnetically operated valves, current for which is obtained from a 50-volt tap from the auto-transformer. The sequence of operation is governed by the master controller in conjunction with a system of interlocks which prevents short circuit of the stops between taps from the auto-transformer or improper operation of the controlling mechanism. At any running point four controlling switches are closed. Through the preventive coils approximately the same amount of current is drawn from each of these switches and the leads to which they are connected. To change to a higher voltage on the motors, the master controller is moved to the next notch, opening the last switch of the group that is closed and closing the switch next higher, with the result that the motor voltage is shifted up one step. By this arrangement the voltage at the motor will be completely under control of the locomotive driver and may be varied up and down at will without opening more than one-quarter of the load current. Small switches in the circuits to the magnets of the reversing switches will enable any motor or combination of motors to be cut out without disturbing the others.

Every one of the 17 controlling connections provides an efficient running point. This number is ample to prevent any slipping of the driving wheels due to increase of current from one notch to another. Whether empty or heavily loaded, operated in single or multiple units, torque and draw-bar pull may be gradually applied and the locomotive started without a jar.

COLLECTING DEVICES AND OVERHEAD CONSTRUCTION.

Each locomotive unit will be equipped with a pneumatically operated pantagraph trolley to collect current from the overhead lines outside the tunnel and throughout the yards. The proportions of the pantagraph will be such that, when extended, it will make contact with the trolley wire 22 feet above the rail, and, when closed down, the contact shoe will not extend more than 18 inches above the roof of the locomotive. The pantagraph will have a broad base and will be constructed of light and stiff material.

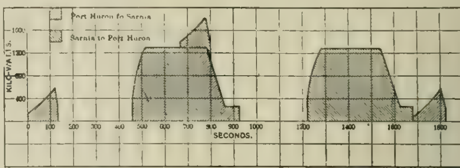

FIG. 7.—CURVE SHOWING POWER REQUIRED TO DRAW 1,000-TON TRAINS THROUGH TUNNEL.

A No. 0000 grooved overhead trolley wire will be suspended from a single ⅝ inch, high strength, double galvanized, steel strand, messenger cable by hangers of varying length in such a manner that the trolley wire will be approximately horizontal The messenger cables will be swung from structural iron bridges located throughout the yards and are of suitable length to span the proper number of tracks. There will also be a small section of track equipped with a trolley line swung by catenary suspension from bracket arms which are supported on lattice-work poles.

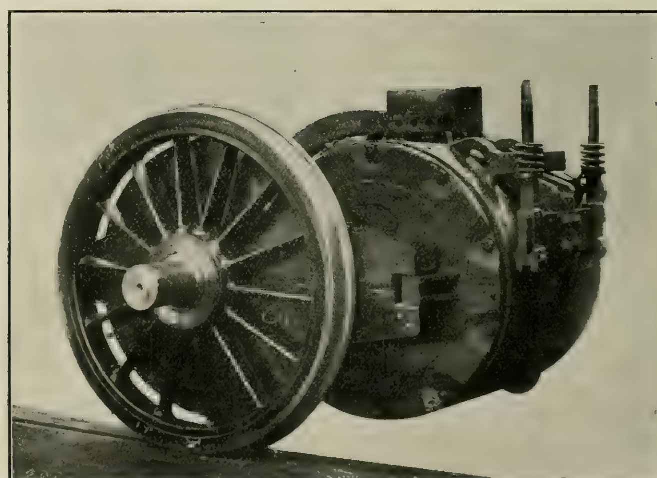

FIG. 6.—250 H.P. SINGLE PHASE ALTERNATING CURRENT RAILWAY MOTOR MOUNTED ON AXLE.

CURRENT SUPPLY.

For the operation of the electric locomotives a complete power plant will be installed by the St. Clair Tunnel Company, including two 1,256 k. w., 3300 volts, 3-phase, 25 cycle, 1500 r.p.m., rotating field Westinghouse steam turbine units with the necessary complement of switchboards, exciters, lightning pro-

tective apparatus, etc. This station will also supply current to light the buildings, yards and tunnel, to operate motor-driven centrifugal and triplex pumps which drain the tunnel and approaches and operate sewage system, to run motors in the round house and for other purposes.

OPERATION.

A pair of the new units will be capable of hauling a thousand-ton train through the tunnel without division. Mechanical considerations limit the advisable weight of train in the tunnel to these figures. Heavier trains can be divided or sent through together with locomotives in front and behind. The service requires that each unit shall take a train of 500 tons through the tunnel block from summit to summit in 15 minutes, under the following conditions:

It will be coupled to a train on a level track at a point 1,200 feet from the summit and must accelerate it up to a speed of 12 miles per hour in two minutes, at the end of which time it will have reached the summit of the grade leading down into the tunnel. It will then run down a grade of 2 per cent. to the level track in the tunnel at a speed not exceeding 25 miles per hour, continue on the practically level stretch under the river, and then draw the train up a 2 per cent. grade at the rate of 10 miles per hour to the level track beyond the tunnel approach on the other side. It must then gradually accelerate the train until a speed of 18 miles an hour is reached. Each unit must be capable of exerting a tractive effort of 25,000 pounds for a period of 5 minutes in addition to the energy required to accelerate the train at the starting point and to run with it into the terminal yard, from which point it must immediately run back to a position 1,200 feet from the summit, couple to another train and be ready to start through the tunnel in the opposite direction. It must therefore make a run of the character described every 30 minutes.

The contract for the entire equipment was taken by the Westinghouse Electric & Manufacturing Company, of Pitisburg, Pa., through the Canadian Westinghouse Company, Limited, of Hamilton, Ont. A large part of the apparatus will be constructed in the works of Canadian Company at Hamilton, and various Westinghouse interests will cooperate to complete the work.

HIGH-SPEED TRACTION.

The high-speed tests on the Zossen experimental track near Berlin have furnished a large amount of valuable data concerning high-speed traction. The following deductions from the tests give some suggestions that have not before been made, and are interesting as showing those features of construction of rolling and line that seem best adapted for such roads to Mr. Charles A. Mudge, formerly chief engineer of the Allgemeine Elektricitats Gesellschaft : 1. Keep the car body as near the rail as possible. 2. Arrange all heavy pieces of apparatus so that their centers of gravity lie in the center of the car, or symmetrically placed to it, and as near the earth as possible. 3. Make all apparatus above the car floor as light as practicable. 4. Make the overhead trolley contact above the car, in preference to the side. 5. Support the motors flexibly on the axles. 6. Give the front of the car a wedge shape. 7. Support the car body on the truck frame at some distance from the center bolt, and allow it a flexibility at right angles to the track, independently of the truck. 8. Make the total wheel base of the truck of ample dimensions, not less than one-fifth of the length of the car. 9. Build the road as straight as possible, and where more than one track is used, space them farther apart than is customary. 10. On curves make the approaches of the elevated side of the track longer.

MOONLIGHT SCHEDULE FOR MARCH.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Mar. 1	10 30	Mar. 2	5 40	7 10
2	11 30	3	5 40	6 10
4	0 20	4	5 40	5 20
5	1 15	5	5 40	4 25
6	2 00	6	5 40	3 40
7	2 50	7	5 40	2 50
8	3 30	8	5 40	2 10
9	No Light	9	No Light	....
10	"	10	"	....
11	6 30	11	8 40	2 10
12	6 30	12	9 50	3 20
13	6 30	13	11 00	4 30
14	6 30	15	0 15	5 45
15	6 30	16	1 30	7 00
16	6 30	17	2 30	8 00
17	6 30	18	3 30	9 00
18	6 40	19	4 30	9 50
19	6 40	20	5 30	10 50
20	6 40	21	5 30	10 50
21	6 40	22	5 20	10 40
22	6 40	23	5 20	10 40
23	6 40	24	5 20	10 40
24	6 40	25	5 20	10 40
25	6 40	26	5 10	10 30
26	6 50	27	5 10	10 20
27	6 50	28	5 10	10 20
28	6 50	29	5 10	10 20
29	6 50	30	5 10	10 20
30	10 15	31	5 00	6 45
31	11 00	Apr. 1	5 00	6 00
		Total	....	210 15

DRY BATTERIES.

The Berlin Electrical Manufacturing Company, Berlin, Ont., are introducing to the Canadian trade the "Best" dry battery for gas and gasoline engines, automobiles, telephones and all open circuit electrical work. They claim to be the only manufacturers of dry batteries and flash lights in Canada. It is their intention to make only high-grade batteries, to register

22 amperes and 16 10 volts, and they are backing up their battery with the guarantee that it is as good if not better than any battery made in the United States.

The Berlin Electrical Manufacturing Company are also manufacturers of the B. & W. automatic time switch.

CANADIAN

Electrical News

AND ENGINEERING JOURNAL

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Advertising rates sent promptly on application. Orders for advertising should reach the office of publication not later than the 1st day of the month immediately preceding date of issue. Changes in advertisements will be made whenever desired, without cost to the advertiser, but to insure proper compliance with the instructions of the advertiser, requests for change should reach the office as early as the 26th day of the month for the succeeding month's issue.

SUBSCRIPTIONS.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Direct Current Transmission. We made comment some months ago upon the sixty thousand volt direct current transmission scheme for Lyons and predicted that more would be heard upon this subject in the near future. Quite recently a scheme has been announced to transmit power in South Africa from Zambesi to the Rand by means of direct current, the distance between these two points being seven hundred miles, and it being figured that the delivered horse power would be approximately twenty thousand. An article has recently been published from the very able pen of Mr. Frank J. Sprague covering in general the question of long distance transmission by direct current, and dealing more specifically with the Rand project. It is surprising to find, when going into this matter, that the engineers have figured a line loss of between thirty and fifty per cent. While this is considerably in excess of the estimated loss in any alternating current line, still it must be considered that the great distance of seven hundred miles is contemplated, and also that inasmuch as water is the source of the power, this loss will not mean anything more than the loss in capacity of the machines at the generating station, that is to say, with a fifty per cent. line loss the capacity of the power house will have to be double that of the sub-station. Some years ago, before alternating current transmission was recognized, Mr. Sprague points out that he presented a paper before the Franklin Institute of Philadelphia on power transmission and advocated at that time the use of series wound direct current generators connected in series groups, so that a high line voltage and consequent low line drop could be obtained. As a matter of fact there are two such plants in successful operation in Europe to-day, and while engineers are prone to state that the direct current scheme is not worth while, we think that at least the idea should be given some thought in the future, inasmuch as we now have indisputable evidence before us that the idea can be successfully carried out. Mr. Sprague's paper is of decided interest and he presents various equations which deal with the ratio of generator to sub-station voltage, line voltage, line loss, and other pertinent features. His paper has, of course, come in for considerable criticism and it is said that several important points have been overlooked. While this is undoubtedly true, it must be remembered that in dealing with a subject of this kind a great many assumptions have to be made, for there are, as yet, no experimental or practical tests with the voltages which are proposed, and in presenting a matter of this kind before the public Mr. Sprague certainly deserves the thanks of the profession.

Members of the American Institute of Electrical Engineers can easily call to mind the question of long distance transmission by alternating current, presented before that body by Mr. Ralph D. Mershon, and will remember that while this engineer came in for much criticism, still his work was decidedly of a pioneer nature and great praise was due him for his efforts. We have now before us papers by two very prominent men, one on long distance transmissions by alternating current and the other by direct current, and it is to be hoped that other engineers will go into these matters with as much thoroughness as possible and carry the proposals a step nearer to realization. Direct current

transmission presents to the average engineer conditions which are entirely different from anything with which he has come in contact, but while he is unfamiliar with such conditions, the simplicity of direct current work renders but little study necessary to get well in touch with such matters. The present limit in power transmission is entirely a question of insulation, this question applying to the line and not to the apparatus in either the generator station or the sub-station. Transformers can be built without much difficulty for a working voltage of two hundred thousand, but with even the potentials now in use, namely, sixty thousand, the insulators used on the line have altogether too small a factor of safety. Original investigation on the question of insulators for extremely high potentials rests very much in the hands of the manufacturing companies, and the consulting engineers retained for such purposes, and it is to this source we must look for the development of an insulator which under average atmospheric conditions will prove satisfactory with a higher voltage than sixty thousand. Insulators intended for use at this potential break down at about ninety thousand under the most severe laboratory tests, and it is really doubtful if these tests are as severe as the conditions which will sometimes be encountered in actual service.

A Producer Gas Plant. There was installed some time ago in a Manitoba city a complete producer gas outfit, which is capable of delivering continuously two hundred and fifty horse power, and tests which have since been made show very good results. The equipment, which is of the suction type, consists of a producer, a scrubber and a receiver, all of which work on the generally known principles. The question of fire hazard in connection with producer gas systems has attracted some attention in the past, and it is interesting to note that the risk in the case of the suction system is considered very much less than the risk in the pressure system. Where a considerable volume of gas is made and handled, and this gas passes through many pieces of apparatus, there is always the chance of a leak, and under the pressure system it would follow naturally that the gas would escape into the room through such a leak. On the other hand, where the suction system is used, the effect of a leak in any piece of apparatus is simply to admit air into the equipment at a point which was not figured upon in the plans and specifications, and no damage results.

It seems to be the general impression that the producer gas system is a complicated equipment of pipes, valves, regulators, and such like machinery, but this really is not the case. The whole equipment is exceedingly simple. The producer can be likened to an ordinary base burner stove and is closed air tight at all points except under the grate, the coal feeding down through a hopper at the top in which there is a simple arrangement to keep air from entering. The amount of air which passes in through the grates at the bottom is not sufficient to make a complete combustion, and consequently large quantities of incandescent gas pass off from the coal at the top and go out through a pipe located in the upper part of the producer. This pipe conveys the gas to what is called a scrubber, but between the producer and the scrubber there is a steam generator mounted on the pipe which connects the two pieces of apparatus mentioned. This steam generator really consists of a water jacket round this pipe, in which water is evaporated by the heat in the gas. While the steam generator has the production of steam as its prime object, it also has a secondary object, inasmuch as it naturally removes a good deal of the heat from the gas and allows it to be delivered to the scrubber in a condition which is comparatively cool. The steam from the steam generator is delivered at the bottom of the producer under the grates and passes up through the fire with the air, the steam having a marked effect on the quality of the gas as it leaves the producer. The scrubber is a vertical cylinder of metal, filled with coke which is subjected to a constant spray of cold water. In passing through this wet coke the gas is purified and cooled and will naturally take up a certain amount of moisture. The gas is then passed into the receiver, the water is eliminated, and cold dry gas goes to an engine of the ordinary type. From the above it will be seen that the whole equipment is extremely simple, and any man who has a knowledge of gas engines, and the principles of operation of such machines, would, with very little instruction, be entirely competent to take hold of the producer end and get satisfactory results.

On the equipment under consideration, tests were made with two kinds of coal, namely, the lowest grade of Souris coal and a good grade of Anthracite, the the former costing $3 per ton and the latter $6.50 per ton, laid down at the plant. For the Souris coal a record of two and one quarter pounds per horse power per hour was obtained, while with Anthracite the figure was slightly less than two pounds. This covered practically the first test runs made on the equipment, and at that time it was considered quite possible, with everything working in first class shape, to make a record of one and three quarter pounds of Souris coal and one and one quarter for the Anthracite. It is interesting to note the statement that with Anthracite coal only one man was required for the whole equipment, while with the Souris coal two men were required. In connection with this it must also be considered that the storage space required by the Anthracite is less than that required by the Souris, and it is taken from this that the actual cost of operating with either Souris or Anthracite is the same. In connection with the first cost of the equipment, it is stated that this particular plant cost about twenty-five per cent. more than an equipment of the same power consisting of boiler and engine, and therefore the fixed charges on the producer plant would only be a little more than twenty-five per cent. greater than the fixed charges on a similar steam plant. We say a little greater because we believe that with the gas producer plant a slightly increased rate of depreciation should be allowed. In giving consideration to the items of coal consumption, water consumption and labor, we find that the gas producer plant shows an enormous saving, and that the increase in the fixed charges is more than offset by the reduction in other departments. Producer gas equipments, while used for some years on the Continent, are comparatively new in Canada and the United States, but so far the experience over here has been similar to that obtained in Europe, namely, no steam equipment can hope to compete with a producer gas outfit.

THE MARITIME ELECTRICAL ASSOCIATION

Pursuant to notice, the reorganized Maritime Electrical Association held its first meeting in the Council Chamber of the City Hall, Halifax, N.S., on January 18th.

Mr. P.R. Colpitt occupied the chair and called the meeting to order at 10 o'clock. Mr. C. L. Goudge was appointed secretary pro tem, and after reading the minutes of preliminary meetings Mayor McIlreath was introduced by the chairman and in a few well chosen words welcomed the visiting members of the Association to the city. Mr. F. A. Bowman, of Sydney, replied in suitable terms.

The business of the meeting was then proceeded with and a committee was appointed to nominate officers for the ensuing term. While this committee was preparing its report the secretary was fully employed filling in applications for membership. Before receiving the nominating committee's report the secretary read the names of 25 applicants for membership, which were duly balloted for and accepted.

The following officers were elected :

President, P. R. Colpitt, city electrician, Halifax; vice-president, F. A. Bowman, manager Eastern Telephone Company, Sydney; secretary, T.N. Goudge, secretary Nova Scotia Telephone Company, Halifax.

Executive Committee—C.W. McKee, J.A. Farquhar, J. H. Winfield, P. A. Freeman, Halifax; A. F. Townsend, Sydney; C. E. Wadden, New Glasgow; S.G. Chambers, Truro; W.A. Winfield, Charlottetown, P.E.I.; W. W. Wells, St. John; C. W. Fairweather, Moncton; C. F. Brown, Yarmouth; E. L. Nash, Lunenburg.

AFTERNOON SESSION.

The business of the convention was resumed at 3 o'clock. The Executive Committee submitted the following amendments to the constitution :

1st. That Convention meetings of this Association be held annually in the summer season, time and place to be decided by the Executive Committee.

2nd. That local branches of this Association may be formed in any locality in our jurisdiction where five or more members can meet, subject to the following conditions, viz : The request for such organization to be forwarded to the general secretary, who will submit the proposal to the Executive Committee. The proposal being favorably received, permission to be granted for such organization when a sufficient number of such local societies have been organized ; a schedule of dates of their meetings to be printed and forwarded to each member of the parent body.

After some discussion the amendments were adopted as read.

The balance of the time was occupied in discussion, one of the subjects being the joint ownership of pole lines, the relative position of different classes of wires on said poles and charges for pin rentals. The discussion resulted in the appointment of a committee to look into the matter and report at next meeting. Another question discussed was the need of an inspector of interior wiring and whose duty it was to appoint him.

Mr. G.S. Chambers said that the town of Truro had electric lights before any other town in the province. They had plate covered wires and wooden cleats, and the electric light station supplied power for three thousand lights. He had often been much disturbed over the inefficiency of the wiring. About three or four years ago Mr. Hamilton came up and discovered the defects, and the whole town was re-wired.

The secretary reported a membership of 78, 47 of whom were newly elected, and funds on hand amounting to $125.

Mr. J. H. Winfield, in proposing a vote of thanks to the Halifax members who had so successfully brought the association into new life, expressed regret that the association had, because of unforeseen circumstances, been compelled to remain inactive for a term of years, but he believed that it had now started on a career of considerable activity and usefulness.

THE BANQUET.

In the evening a complimentary dinner was tendered to the visiting members at the Queen's Hotel. It was admirably conducted and a most enjoyable affair. Mr. P. R. Colpitt, the newly-elected president, was in the chair. He opened the toast list, proposing "The King," which was duly honored.

Mr. J. C. Mackintosh, in proposing the next toast, congratulated the members on the interest shown in the convention and the excellence of the banquet. He remembered as a boy seeing the first telegraph pole ever put up in Halifax, in 1849, near the Common, at the celebration of the anniversary of the centenary of Halifax. Since then telegraphing, cabling, telephoning and electric lighting had developed to a remarkable degree. He told of the first telephone message he heard in 1878 at the Western Union Telegraph office, which was considered wonderful. When he was a boy in the city of Halifax they were just starting gas lights. In heating, transportation and lighting electricity was the feature of the present time. He concluded his remarks with welcoming the visitors and proposed the health of the visiting members and guests.

Mr. B.W. Chipman made an eloquent and interesting speech on behalf of the guests. He was almost as old as Mr. Mackintosh, and he remembered the first telegraph pole, and told of how he was present on an ocassion in the country years ago when an American gentleman showed the workings of the telegraph system by using the instruments, and showing how the messages were received. He told of the struggle to form the Nova Scotia Telegraph Company and of the success it had since met with.

Mr. F. A. Bowman also responded. He thanked them very kindly for the manner in which they had honored the toast. He had the pleasure while driving along the road this season of seeing the stumps of the old poles placed for the first Atlantic cable. The very large gathering present was an indication of the growth of the electrical industries in the Maritime Provinces. He hoped at some future time to have the association meet at Sydney. Mr. Alex. McKay, Chatham, also made a happy reply.

Mr. P. A. Freeman proposed a toast to the professors

of our colleges, which was replied to by Prof. Sexton, Dalhousie, who spoke of the great progress of Canada, which was now robbing the United States of some of her best citizens. He referred to the introduction of electricity by the Dominion Coal Company in the pits.

Mr. J. H. Winfield gracefully proposed "Our Sister Societies," which was replied to by Mr. Gale, who is in Halifax in the interest of the submarine soundings to be placed in Halifax Harbor. He said he was an American who had come to this country and had his eyes opened with the wonderful progress of Canada. He paid great tribute to the lighthouse service of Canada, which, he said, was the most efficient in the world. The acetylene gas buoys off the harbor were the best in the world, and others were copying them. Nova Scotia was the first to have wireless telegraphy on this side of the water, and now Canada was to have the submarine service which was to be adopted by England, Germany and other nations.

Mr. B. W. Chipman proposed the health of the president and officers, and President Colpitt reponded.

The dinner committee consisted of Messrs. James Farquhar, W. M. Godsoe and J. A. Dunn.

THE MEMBERSHIP.

E.M. Archibald, chief electrician Dominion Coal Co., Sydney, N.S.
H. P. Archibald, B.A.Sc., Acadia College, Wolfville, N. S.
C. H. Abbott, R. E. T. Pringle Co., St. John, N. B.
John S. Ackhurst, Canadian General Electric Co., Halifax, N.S.
F. A. Bowman, manager Eastern Telephone Co., Sydney, N. S.
J.D Briggs, supt. construction N. S. Telephone Co., Wellington, N. S.
C. F. Brown, supt. Yarmouth Amalgamated Telephone Co., Yarmouth, N. S.
R. E Burgess, B.A.Sc., Wolfville, N. S.
Harold Baker, Nova Scotia Telephone Co., Halifax, N. S.
G. W. Baker, supt. Eastern Telephone Co., Sydney, N. S.
S. G. Chambers, president Truro Electric Co., Truro, N. S.
J. W. Crosby, manager Halifax Electric Tramway Co., Halifax, N. S.
P. R. Colpitt, city electrician, Halifax, N. S.
J. Daley, president Digby Electric Co., Digby, N. S.
S. S. Dickinson, supt. Cable Co., Hazel Hill, N. S.
J. A. Dunn, electrical contractor, Halifax, N. S.
J. T. Dovey, John Starr, Son & Co., Halifax, N. S.
L. Erwin, manager Dartmouth Electric Co., Dartmouth, N. S.
P.A. Freeman, chief engineer Halifax Tramway Co., Halifax, N.S.
Jas. Farquhar, electrical contractor, Halifax, N. S.
S. Fenn, supt. Direct Cable Co., Halifax, N. S.
C. W. Fairweather, city electrician, Moncton, N. B.
L.C. Gelling, supt. Nova Scotia Telephone Co., Bridgewater, N.S.
Jas. Graham, construction engineer Canadian General Electric Co, Halifax, N. S.
E. L. Gilpin, Sydney, N. S.
W. M. Godsoe, manager C.P.R. Telegraph Co., Halifax, N. S.
W. S. Grant, Nova Scotia Telephone Co., Halifax, N. S.
F. A. Hamilton, electrician, Commercial Cable Co., Dartmouth, N.S.
E. G. Hoyt, supt. Nova Scotia Telephone Co., Amherst, N. S.
J. J. Hamm, electrical contractor, Halifax, N. S.
W. W. Hoyt, electrician Farquhar Bros., Halifax, N. S.
H. V. Jameson, New Glasgow, N. S.
C. R. Kinnear, Halifax Tramway Co., Halifax, N. S.
T. W. Kelly, engineer Halifax Tramway Co., Halifax, N. S.
G. W. Luke, electrician Halifax Tramway Co., Halifax, N. S.
Frank Lovegreen, King's College, Sydney, N. S.
J. C. McIntosh, banker, Halifax, N. S.
Archibald Miller, Government meter inspector, Halifax, N. S.
P. Mosher, supt. Electric Co., Windsor, N. S.
Wm. A. McKay, electrical contractor, Sydney N. S.
A. N. McKay, electrical contractor, Sydney, N. S.
Chas. W. McKee, manager W. U. Telegraph Co., Halifax, N.S.
J. C. Mitchell, N. S. Telephone Co., Halifax, N. S.
J. T. Murphy, Canadian General Electric Co., Halifax, N. S.
H. M. Mitchell, supt. Nova Scotia Telephone Co., New Glasgow, N. S.
J. L. McDonald, Farquhar Bros., Halifax, N. S.
A. E. Morrison, manager Anglo-American Telegraph Co., Charlottetown, P.E.I.
G. McDonald, Prince Edward Island Telephone Co., Charlottetown, P.E.I.
H. M. McDonald, Nova Scotia Telephone Co., Halifax, N. S.
E. L. Nash, manager Electric Co., Lunenburg, N. S.
W. Pickles, electrician Dominion Coal Co., Glace Bay, N. S.
J. W. Pilcher, district manager Canadian General Electric Co., Halifax, N. S.
Geo. Phillips, electrician John Starr, Son & Co., Halifax, N.S.
C. C. Starr, district manager Westinghouse Co., Halifax, N. S.
Henry Ritchie, electrical contractor, New Glasgow, N. S.
E. H. Smith, R. E. T. Pringle Co., St. John, N. B.
W. Soper, electrician Halifax Tramway Co., Halifax, N. S.
A.F. Townsend, manager Cape Breton Electric Co., Sydney, N.S.
C. E. Wadden, manager New Glasgow Electric Co., New Glasgow, N. S.
J. H. Winfield, general manager Nova Scotia Telephone Co., Halifax, N. S.
W. A. Winfield, manager Prince Edward Island Telephone Co., Charlottetown, P.E.I.
T.A Wright, electrician Nova Scotia Telephone Co., Halifax, N.S.
W. W. Wells, manager New Brunswick Telephone Co., St. John, N. B.
T. S. Young, CANADIAN ELECTRICAL NEWS, Toronto.
G. W. Baker, supt. Eastern Telephone Co., Sydney, N. S.
G. A. Innes, Nova Scotia Telephone Co., Halifax, N. S.
C. S. Garroway, Nova Scotia Telephone Co., Halifax, N. S.
C. B. Hills, Halifax, N. S.
C. S. Blanchard, Nova Scotia Telephone Co., Halifax, N. S.
T.N. Goudge, secretary Nova Scotia Telephone Co., Halifax, N.S.
Alex. McKay, supt. of works, Chatham, N. B.
G. F. Freeman, manager Valley Telephone Co., Middleton, N.S.
M. Miller, supt. construction Halifax Tramway Co., Halifax, N.S.
E.B. Jack, prof. civil engineering Dalhousie College, Halifax, N.S.
F. H. Sexton, prof. mining engineering Dalhousie College, Halifax, N. S.
D. Ormston, engineer, New Glasgow, N. S.

ELECTRIC POWER EQUIPMENT.

Mr. R.S. Kelsch, consulting engineer, of Montreal, has purchased the entire electrical equipment for operating the Ogilvie Flour Mills Company's mills at Fort William, Ont., and Winnipeg, Manitoba. All of the Ogilvie Company's elevators, warehouses, mills, barrel factories, etc., at Winnipeg, will be operated by electric power after June 1st, 1906. The power will be furnished by the Winnipeg General Power Company, and at Fort William the power will be supplied from the Kaministiquia Power Company's new development.

Contracts for the above apparatus amount to over $75,000 and are equally divided between the Canadian General Electric Company and the Allis-Chalmers-Bullock Company, Limited. They include a 1100 h.p. synchronous motor, an 800 h.p. induction motor, 250 h.p. induction motor, switchboards, transformers and a large number of induction motors ranging from 5 h.p. to 150 h.p. The Dominion Bridge Company secured the contract for steel work, cranes, etc., for the new motor rooms at Fort William and Winnipeg. These motor rooms will be strictly fireproof, have marble wainscotting and terazzo mosaic floors.

The Sarnia Street Railway Company, Sarnia, Ont., have elected the following officers: President, J. D. Beatty; vice-president, James Flintoft; manager and secretary, H. W. Mills; treasurer, George E. Wadland.

The directors of the Guelph Street Railway Company have under consideration the extension of their road to Hespeler and Puslinch Lake. This would mean an extension of about eleven miles, at a probable cost of $150,000.

The Grand Falls Power Company have deposited with the Minister of Public Works at Ottawa the plans of dam and other works proposed to be constructed in the St. John river at Grand Falls, N.B., for the purpose of developing electric energy.

NEW MANAGER OF ALLIS-CHALMERS-BULLOCK.

It is officially announced that Mr. James A. Milne, who has for a number of years been Comptroller of the Allis-Chalmers Company, Milwaukee, has accepted the position of General Manger of Allis-Chalmers-Bullock, Limited, Montreal, Canada, to become effective on or before May 1st, 1906.

Mr. Milne is a native of Canada, having been born at Waterdown, Ontario, in 1872. After completing a public school and collegiate course, he began his business career at Toronto in 1888. During the ensuing four years he was with Robert Simpson & Company and Wyld, Grassett & Darling, of that place; but in 1892 he removed to Chicago, entering the employ of Carson, Pirie, Scott & Company. Subsequently he worked for Reid-Murdock & Company and the Chicago Packing & Provision Company—for the latter as chief accountant. Then he became associated with Jones, Caesar & Company, chartered accountants of Chicago and New York, and it was this connection which

MR. J. A. MILNE,
General Manager Allis-Chalmers-Bullock, Limited.

brought him into touch with the Allis-Chalmers Company. In August, 1901, he entered its employ, as Chief Cost Clerk, and one month later was appointed acting Comptroller, being formally elected to that position at the meeting of the Board of Directors in May, 1902. Since the early part of last autumn, Mr. Milne has been one of the directors of Allis-Chalmers-Bullock, Limited, and the fact that he still retains Canadian citizenship, and is deeply attached to his early associations, has been an important factor in influencing him to heed a recall to the Dominion.

The Allis-Chalmers-Bullock, Limited, of Montreal, is an allied interest of the Allis-Chalmers Company, and owns a large manufacturing plant located at Montreal, the direct management of which will now be assumed by Mr. Milne.

The Canadian Company is conducted as an entirely separate organization, but, in addition to its own production, sells the products of Allis-Chalmers Company in the Dominion of Canada.

The ratepayers of Carberry, Man., will this month vote on a by-law to provide funds to install an electric light plant.

ELECTRICAL INSPECTION.

[COMMUNICATED.]

The much talked of civic inspection of electric wiring in Toronto seems to be dying a natural death or at least going into the trance that it assumes at each awakening.

There are different aspects of this question and some remarks on the situation may not be out of place. Electrical inspection in a large city should be carried out jointly by the city and the underwriters so that they could arrive at a mutual understanding and the present "dabbling" in the trade be regulated. The city regulates our streets, our railway, our plumbing and our buildings, year even scaffolding, but electric wiring can be done any way, by any one and in any building.

It is not only dangerous but positively ridiculous that well trained and experienced electric workers must sit and twiddle their fingers while amateurs, firemen, carpenters, in fact any self constituted electrician throws up wiring unmolested. The idea of merely appointing a civic inspector or even 20 civic inspectors would be futile to prevent this, but the remedy is simple and would cost the city practically nothing. They do not require to create any new office but simply to regulate the work by simple by-laws and the underwriters should be capable and ready to see they are not disregarded.

The Underwriters demand that wiring be done in accordance with the "National Code" and so far as new buildings are concerned there is not much to be improved upon, but what profit it if after the completion of same any one is at liberty to add defective work thereto and say nothing about it to any one. Let the city of Toronto pass a by-law decreeing that all electric work within the city limits comform to the National code of the Underwriters and make it a misdemeanor if it is not lived up to.

We understand that the executive committee of the local union of the electrical workers are shortly to petition the city of Toronto that something he done towards regulating electric wiring, and that they will request the city to extend the necessary authority to the chief electrical inspector of the Underwriters that may be necessary to enable him to enforce the National code and also stop promiscuous electric work, as well as having authority to enforce a standard for the trade.

NEW ELECTRIC PLANT.

Foley, Lock & Larson, wholesale grocers, Winnipeg, have just installed one of the most complete electric plants in the mercantile line in the West. This plant consists of three 100 horse power boilers, manufactured by the Vulcan Iron Works, of Winnipeg; two tandem compound high speed engines, manufactured by A. L. Ide & Sons, of Springfield, Ill.; two generators, 62½ k.w. each, with direct connection to 34 motors ranging from one to 30 horse power. The motors and generators were made by the Westinghouse Electric Company, of Pittsburg, Penn. There are five elevators, each having a special motor. The lighting consists of 300 16-candle power lights with 15 arc lights. The wiring and lighting was done by Mr. E.S. Harrison, of Winnipeg, under the supervision of their own electrical engineer. A system of ventilation has been installed which gives fresh air to all floors. The boilers were installed by Messrs. Gate & Sons, of Winnipeg, and the engines by the makers.

ELECTRIC LIGHTS AS TIME-SIGNALS.

By James Asher.

It recently occurred to the writer that the correct time might be correctly signalled in cities and towns in such a manner that the inmates of nearly all the houses might easily receive such signals. The method might be carried out as follows: At nine o'clock each evening the attendent at the central station might momentarily open the switch of the circuit of the arc lamps on the streets. This would cause each electric arc light on the circuit to blink for a moment. Now, supposing that the attendant at the central station has a well-regulated watch, and obtains government time-signals each day, he would be enabled to send time-signals throughout his town with a degree of accuracy and precision comparable to that obtained by the use of a public time-ball. One or more arc lamps can be seen from nearly every house in our cities and towns, hence nearly all the inhabitants would be enabled to receive the correct time each evening, and set their watches and clocks accordingly. Moreover, nearly every person in the possession of a clock or a watch would be enabled to regulate his timekeeper.

Of course, time-signalling by means of incandescent lamps might be done in a similar manner, and with still greater convenience, where houses are supplied with current for incandescent lamps from a lighting station. Factories, department stores, and establishments of all kinds, might use such signals. Even where an establishment is not connected with a central station, time signals might be given by the local tender of the dynamo belonging to the establishment.

Such signals might also be given on ships and on railway trains in which the electric light is used.

In many central stations more than one electric circuit has its origin. The tender of the dynamo would open and close one switch after another in quick succession, until all had been momentarily opened. The inhabitants would be informed concerning the exact minute and second at which the lights on each circuit would blink. For example, a card in each house might state that on circuit No. 5 the arc lamps would blink at 9 h. 1 m. 15 sec. in the evening.

ELECTRICITY IN FARMING.

Electricity has become an important factor in farming operations in that part of British Columbia lying between Vancouver and New Westminster running west to the coast line, including Lulu Island at the mouth of the Fraser river. The British Columbia Electrical Railway Company have greatly extended their lines and are covering that portion of the province with a perfect system of light and power wires at a cost of over $5,000. The section around Burnaby Lake has been electrified and when the ice in the winter is strong enough to permit skating, it will be possible to engage in that pastime under the rays of electric lights, though far removed from the city. A line a mile and a half long has been constructed north from the [illegible] substation and extending for a mile along [illegible] of the lake. Along the route of this line are located many flourishing farms, which will enjoy electric light, as well as power for the operation of farm machinery, such as hay-cutters, root-crushers, cream separators, etc. By arrangement [illegible] management of the British Columbia Electric Railway Company, the farmers residing at some distance from this new line will have branch lines constructed to their farms without having to pay the cost of connection, which in some cases would be considerable. The farmers have agreed to dig the post holes and supply the poles for these branch lines. The Company's workmen will erect the poles and string the wire. Another line has been extended from Burnaby substation along the interurban tram line to the New Westminster city limits. This will supply a large number of farms and suburban residences besides the new municipal hall at Burnaby.

The electric system on Lulu Island is to be augmented in the near future by the addition of a line two miles long, giving electrical connection to a large number of farms and residences en route. It is the aim of the Electric Company to give the advantages of cheap electric light and power to every farmer and resident within reasonable reach of the company's lines.

COMPETITION FOR THE EDISON MEDAL.

The American Institute of Electrical Engineers have recently sent a circular to institutions of learning concerning the conditions governing the competition for and award of the Edison Medal for the year 1906.

Sufficient funds will be available from the net income of the trust fund, created in 1904 to establish the Edison Medal, to provide for the award of the medal for the year 1906.

The by-laws provide that not more than two students may compete in any one year from any one institution of learning qualified to present competitors; that each competing thesis or record of research must be the work of a single qualified student only; that no student may compete unless he has graduated when not more than twenty-five years of age and received a degree during the year for which the medal shall be awarded in some course of study normally requiring not less than two years of continuous residence and work, which course of study shall include the branch of Electrical Engineering; and that each student shall be separately presented through the faculty of the particular institution at which he is a student by means of a presentation notice properly filled in.

The theses or records of research themselves should be received by the Secretary of the Institute by October 1st.

E. E.—WHAT DOES IT MEAN?

There has recently come to our notice the bill head of a person doing business as a wiring contractor for lighting and bells. This ambitious youth is an employee of a gas company and has never had any education in electrical engineering outside of his vocation as a gas employee and electrical contractor "on the side." The affix "E. E." may mean something else to him, but to the electrical fraternity it implies a title and that of [illegible]rical Engineer. It is unfortunate that the [illegible] of such titles is not by some means [illegible]

The Finch Electric Light & Manufacturing Company, Limited has been incorporated with a capital of $50,000 and head office at Finch, Ont. It is proposed to manufacture and deal in lumber and building material and install and operate an electric lighting plant. The directors include Messrs. A. M. Smirl, mill owner, and Jacob McQuaig, carriage manufacturer, of the Township of Finch.

Power Plant Economics

At the twenty-ninth regular meeting of the Toronto Branch of the American Institute of Electrical Engineers, held at the Engineers' Club, 96 King street west, on February 9th, the subject for discussion was "Power Plant Economics". Mr. R. G. Black abstracted in a very able manner the interesting paper presented by Mr. Henry G. Stott before the parent institution, in which he considered the relative advantages of the reciprocating steam engine, the steam turbine and the gas engine and declared that a gas engine plant in combination with a steam turbine plant offers the most attractive proposition for efficiency and reliability to-day. Space will not permit of reproducing the paper in full, but an abstract is given below, accompanied by the steam-consumption curve of the reciprocating engine.

In regard to this development the author wishes to direct attention to the basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyze the entire plant from the coal to the bus-bars: first, in regard to efficiency; secondly, in regard to the effect of load-factor upon investment; and thirdly, the effect of the first and second upon the total cost of producing the kilowatt hour, which is the ultimate test of the skill of the designer and operator.

In Table 1 will be found a complete analysis of the losses found in a year's operation of what is probably one of the most efficient plants in existence to-day and, therefore, typical of the present state of the art.

TABLE No. 1.

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL INTO ELECTRICITY.

	B.t.u.	%	B.t.u.	%
1. B.t.u. per pound of coal supplied	14150	100.0		
2. Loss in ashes			340	2.4
3. Loss to stack			3 212	22.7
4. Loss in boiler radiation and leakage			1 131	8.0
5. Returned by feed-water heater	441	3.1		
6. Returned by economizer	960	6.8		
7. Loss in pipe radiation			28	0.2
8. Delivered to circulator			223	1.6
9. Delivered to feed-pump			203	1.4
10. Loss in leakage and high-pressure drips			152	1.1
11. Delivered to small auxiliaries			51	0.4
12. Heating			31	0.2
13. Loss in engine friction			111	0.8
14. Electrical losses			36	0.3
15. Engine radiation losses			28	0.2
16. Rejected to condenser			8 524	60.1
17. To house auxiliaries			29	0.2
	15551	109.9	14 099	99.6
	14099	99.6		
Delivered to bus-bar	1452	10.3		

DISCUSSION OF DATA IN TABLE 1.

Item 1. B.t.u. per Pound of Coal Supplied.—The thermal value of the coal used is evidently of prime importance, as it affects the cost efficiency of the entire plant. The method of purchasing coal used in the plant from which this heat balance is derived is that of paying for B.t.u. only, with suitable restrictions on the maximum permissible amount of volatile matter, ash, and sulphur.

Item 3. Loss to Stack.—This is one of the most vulnerable points to attack, as the loss of 22.7 per cent. is very large. Recent investigations show that promising results may be obtained by the use of more scientific methods in the boiler room. In practically all cases it will be found that this loss is due almost entirely to admitting too much air to the combustion chamber, resulting in cooling of the furnace. This result is usually produced by "holes" in the fire; these "holes" may be due to several causes, but usually are due to carelessness on the part of the fireman. It seems reasonable to assume that the 22.7 per cent. loss to stack can, by scientific methods in the fire room, be reduced to about 12.7 per cent. and possibly to 10 per cent.

Item 4.—The loss in boiler radiation and leakage, amounting to eight per cent., is largely due to the inefficient boiler setting of brick which, besides permitting radiation, admits a large amount of air by infiltration. This infiltration will increase with the draught. The remedy for this radiation and infiltration loss is evidently to use new methods of boiler setting, such as an iron plate air-tight case enclosing a carbonate of magnesia lining outside the brickwork.

Item 5. Returned by Feed-Water Heater.—The importance of getting the feed water to the maximum temperature obtainable is generally recognized, and would seem to indicate that all auxiliaries should be steam driven so that their exhaust may be utilized in the feed-water heater; in this way the auxiliaries may operate at about 80 per cent. thermal efficiency.

Item 6.—Owing to the difficulty of pumping water at temperatures above 150 degrees fahr., when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed-water temperature to 200 or 250 degrees fahr. As this increase of temperature is obtained from the waste gases at no expense for fuel, it only becomes necessary to consider the load-factor, in order to decide whether economizers should be installed or not. In practically all cases where the load factor exceeds 25 per cent. the investment will be justified.

Item 7. Loss in Pipe Radiation.—By the use of two-layer pipe covering, each layer being approximately 1.5-in. thick, and sections put on in such manner that all joints are broken, the radiation losses have become practically negligible.

Items 8 and 9. Heat Delivered to Circulating and Boiler-Feed Pumps.—As these auxiliaries may be either electrically driven or steam driven it is interesting to note that the thermal efficiency of the electrically-driven pumps would be equal to the thermal efficiency of the plant, multiplied by both the efficiency of conversion from the alternating to direct current and by the motor efficiency. In this case, there would be a net thermal efficiency of $10.3 \times 0.93 \times 0.90 = 8.63$ per cent., whereas the thermal efficiency of the steam-driven auxiliary discharging its exhaust into a feed-water heater at atmospheric pressure would be approximately 87 per cent.

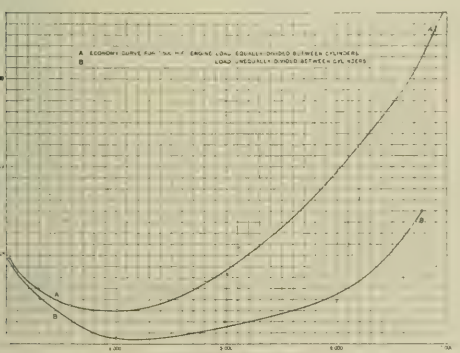
Item 13. Loss in Engine Friction. — Recent tests of a 7,500-h.p. reciprocating engine show a mechanical efficiency of 93.65 per cent. at full load, or an engine friction of 6.35 per cent. As this forms only 0.8 per cent. of the total thermal losses it is relatively unimportant. Attention is called to the method of lubricating all the principal bearings by what is known as the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units; after passing through the bearings the oil is returned

by gravity to oil filters in the basement and then pumped up to the reservoir tanks again. About 200 gallons per hour are put through each engine, and of this quantity only about 0.5 per cent is lost. This method of oiling undoubtedly contributes to the general result.

Item 14.—As large electrical generators can now be obtained which give from 98 to 98.5 per cent. efficiency, it would seem as if the limit in design had been reached and that hereafter the problem of design is to be merely one of altering dimensions to suit varying sizes and speeds. While this is true as far as the efficiency is concerned, other problems are continually arising, such as the design of generators for an overload capacity of 100 per cent. to meet the demand for apparatus capable of taking care of great overloads economically for short periods, corresponding to peak loads of a railroad or lighting plant.

Item 16. Rejected to Condenser, 60.1 per cent.—This immediately introduces the thermodynamics of the steam engine, a subject so broad that it will be impossible to do more than touch upon some of the most important points in considering steam engine efficiency.

The efficiency of any heat engine can be expressed by the ratio of $E = \frac{T_1 - T_2}{T_1}$ where T_1 is the absolute temperature of the steam entering the engine and T_2 the absolute temperature of the steam leaving the engine. Thus in the engine house whose steam-consumption



curve is shown herewith, if the initial pressure is 175 lbs. gauge and the vacuum at the low pressure exhaust nozzle is 28 in., then the maximum thermal efficiency is $\frac{837 - 560}{837} = 33$ per cent. This would be true for any form of engine or turbine working between the same temperature limits.

In the curve, however, it is seen that the point of maximum economy shows a steam consumption of approximately 17 lb. per kilowatt-hour, which is equivalent to 20 349 B.t.u. per hour. One kilowatt-hour is equal to 3412 B.t.u. per hour, so that the actual efficiency of the steam engine and generator is $\frac{3\,412}{20\,349} = 16.7$ per cent. As the generator efficiency at this load is approximately 98 per cent. the net engine thermodynamic efficiency is $\frac{16.7}{0.98} = 17$ per cent.

The difference between the theoretical efficiency and the actual is then $33 - 17 = 16$ per cent., of which 6.35 per cent. has already been accounted for in engine friction, so that the balance of 9.65 per cent. is due to cylinder condensation, incomplete expansion, and radiation.

As the friction engine in a two-bearing engine with high-pressure poppet valves and low-pressure Corliss valves has by careful design been reduced to less than 6.5 per cent., gain can not be expected here, so attention must be centered on the loss due to cylinder condensation, etc., amounting to 9.65 per cent., in order to effect any improvement.

Superheated steam is the only remedy at hand and with it we can probably effect an improvement of 5 or 6 per cent. by using such a degree of superheat in the boilers that dry steam will be had at the point of cut-off in the low pressure cylinder.

Any greater amount of superheat than this will merely result in loss to the condenser; for it should be remembered that the cylinder losses increase with the difference in temperature between the steam and exhaust portions of the cycle; in other words, the greater the thermal range of temperature the greater the condensation loss. This would seem to point to the use of more cylinders, but this involves additional first cost and friction as well as more space and higher maintenance charges.

SUMMARY OF ANALYSIS OF HEAT BALANCE.

The present type of power plant using reciprocating engines can be improved in efficiency as follows:

Reduction of stack losses.................. 12%
Reduction in boiler radiation and leakage.... 5%
Reduction in engine losses by use of superheat 6%

resulting in a net increase of thermal efficiency of the entire plant of 4.14 per cent., and bringing up the total thermal efficiency from 10.3 per cent. to 14.44 per cent.

THE STEAM TURBINE.

An inspection of the steam turbine curve, which represents what is probably the best results obtained up to date, shows: first, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine; secondly, that 200 degrees superheat reduces the steam consumption 13.5 per cent. But calculating the total heat units in superheat from $H_1 = H + 0.48\,(t_2 - t_1)$ the B.t.u. per kilowatt-hour are 20.349 for dry saturated steam, whilst for 200 degrees superheat they are 19.008 or a net thermal saving of 6.6 per cent. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo unit would be considerably better than that of the reciprocating engine, with the other great advantage of costing approximately 33 per cent. less for the combined steam motor and electric generator.

HIGH-PRESSURE RECIPROCATING ENGINE WITH LOW-PRESSURE TURBINE ON ITS EXHAUST.

The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high-pressure where relatively it

is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

THE INTERNAL COMBUSTION OR GAS ENGINE.

The gas engine has probably developed more slowly than any other piece of modern apparatus, as it is now thirty years since the Otto gas engine was introduced. It is only within the last ten years that the larger type of engine, from 500 to 2,000 h.p. in size, has appeared. The delay in bringing forward the most efficient motive power known is chiefly due to the difficulty experienced in developing an efficient and inexpensive method of making gas. As far as the production of gas from anthracite and non-caking bituminous coals is concerned this problem has apparently been solved, but it is still in a more or less unsolved condition for the richer bituminous and semi-bituminous caking coals of the Eastern States.

The following heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL CONTAINING 12,500 B.T.U. INTO ELECTRICITY.

	B. t. u.	Per Cent.
1. Loss in gas producer and auxiliaries....	2 500	20.
2. Loss in cooling water in jackets.........	2 375	19.
3. Loss in exhaust gases	3 750	30.
4. Loss in engine friction..................	813	6.5
5. Loss in electric generator...............	62	0.5
6. Total losses..........................	9 500	76.0
7. Converted into electrical energy.........	3 000	24.0
	12 500	100.0

The great objection to the use of the gas engine for electrical purposes has been: first, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

The total investment for a gas-producer plant, all auxiliaries, gas engines, and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

Where natural gas or blast-furnace gas can be obtained the gas engine has out-distanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer-gas plants, it is safe to say that rapid developments will result.

The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that its range of economical load is practically limited to between 50 per cent. load and full load. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage-battery of comparatively large capacity.

NEW TYPE OF PLANT.

Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem ; for the turbine immediately proceeded to act like an ideal storage-battery ; that is, a storage-battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam turbine, and the reciprocating units went on carrying almost constant load, whilst the turbine load fluctuated between 0 and 8000 k.w. in periods of less than 10 seconds.

The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency whilst at the same time removing the only valid objection to the gas engine.

A steam-turbine unit can easily be designed to take care of 100 per cent. overload for a few seconds ; and as the load fluctuations in any plant will probably not average more than 25%, with a maximum of 50% for a few seconds, it would seem that if a plant were designed to operate normally with 50% of its capacity in gas engines and 50% in steam turbines, any fluctuations of load likely to arise in practice could be taken care of.

We have seen that the thermal losses in the gas-engine jacket-water amounted to approximately 19%, and as the water is discharged at a temperature above 100° it can be used to advantage for boiler feed.

The jacket-water necessary for an internal combustion engine will probably be about 40 lb. per kilowatt-hour, assuming that the jacket-water enters at 50° fahr.; then the discharge temperature will be

$$50 + \frac{19 \times 12500}{40 \times 100} = 109.4^\circ \text{ fahr.}$$

As the steam turbine will require only about 15 lb. per kilowatt-hour, including auxiliaries, it is evident that only 37.5% of this heat or 7.1% of the jacket-water loss can be utilized. The other loss in the exhaust gases of 30% can be utilized either in economizers or directly in boilers or superheaters.

Thus by utilizing the waste heat in the gas engines for the purpose of assisting to make steam for the turbines, there can be saved approximately 37% of the total heat lost in the gas engine.

In the summary of analysis of heat balance it was shown that one can reasonably expect to bring the reciprocating engine plant up to a maximum total thermal efficiency of 14.44%, or possibly with steam turbines using superheat, to 15%.

SUMMARY.

1. The present type of steam-power plant can be improved in efficiency about 25 per cent. by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam-turbine plant has an inherent economy 20 per cent. better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of causes.

3. An internal combustion-engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one half its present cost.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the mo th preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. No. 1.—Is the use of the word "inerta" as made in the answer to question No. 1 of your December issue, correct? According to our understanding this word is not a proper one, as "inertia" never tends to keep up speed.

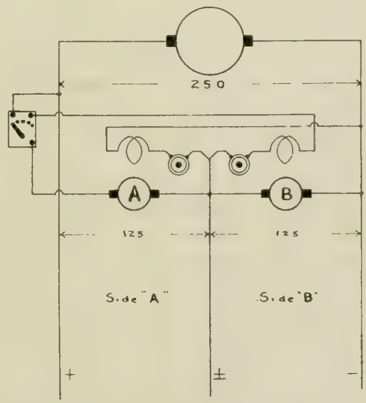
ANS.—Replying to the above question we beg to quote the following definitions taken from the Standard Dictionary. "Inertia"—that property of matter by virtue of which it persists in its state of rest or of uniform motion in a straight line, unless some force changes that state. "Momentum"—that which makes a moving body hard to stop. Words given as synonyms of momentum are inertia and impetus. From the above you will see that our use of the word "inertia" is entirely correct. It might be said that momentum is that portion of the property of inertia applying to bodies in motion and *being stopped*, but this is as far as the meaning goes. Inertia has entirely the same meaning, but will also apply to a body at rest or a moving body the speed of which is being accelerated.

QUES. No. 2.—Please explain in your Question and Answer Department how to magnetize a permanent magnet, and if same be broken could it be welded and magnetized properly? A magnet two pounds weight, "horse shoe," what should it be able to lift?

ANS.—A permanent magnet can be magnetized by winding a coil of wire around it, and passing a current through this wire, or if one pole be touched and held against the pole of a running motor, or generator, the magnetization will also take place. To get the best effects in the first case, the direction of the current in the coil of wire should be such as to make the old polarity of the permanent magnet stronger in preference to neutralizing the old polarity and establishing an opposite one in its place. If a permanent magnet should become broken the two broken pieces will each be magnets by themselves, each having a north and south pole. While these two magnets could be welded together, and while the whole would unquestionably have magnetic strength after the welding was complete and the iron had been remagnetized, we doubt very much if the welding could be done sufficiently well to make the magnet as strong as it could be made before the break occurred. Your question as to what a two pound horse shoe magnet should lift is impossible to answer, as considerable data is required to determine such matters. We would want an absolutely accurate sketch of the magnet, showing its shape and cross section at all points, and the same information would be required of the keeper. Then we would want to know the nature of the metal from which both the magnet and the keeper were made. If this be a permanent magnet to which you refer we could not give you any information whatever, for we could not tell the condition of the magnet. If, however, the magnet is an electro-magnet, i.e., made of soft iron and magnetized by a coil of wire wound around the metal, we would want to know the size and shape of the coil or coils, the size of the wire used and the number of turns. With information as required above we would be able to tell you what the magnet should lift, and if you can prepare such information, and send it to us, we will be glad to answer your question further.

QUES. No. 3.—Please explain with connections a motor generator set known as a booster or equalizer, used on a three-wire direct current lighting system?

ANS.—A balancer set is used where the main generators are 250 volts and it is desired to operate 110 volt lamps on a three wire system, the object of the balancer set being to provide the middle wire. As used, the balancer set consists of two shunt wound motors mounted on a common bed plate and coupled together. The armatures are connected in series, the outside points being connected to the outside wires, across which there is a potential of 250 volts, and the middle wire is taken out from a point between the two armatures. While the field of each motor is sometimes connected across the armature of that motor, better results can be obtained with the connections shown in the diagram, that is to say, with the field of



motor A connected across motor B and the field of B connected across A. Were it not for this balancer set the lamps on one side of the system would be bright while the other side would be dull, providing the number of lamps on one side were less than that on the other, and it is the function of the balancer set to neutralize this unequal condition. Suppose that there are 100 more amperes on side A than on side B. Under such conditions the motor marked B will act as a motor and will take 50 amperes from side B and deliver this energy in the form of mechanical motion to the motor marked A, which will act as a generator and will deliver 50 amperes to side A, thus equalizing the unbalanced condition, the action practically taking 50 amperes off one side and putting it on the other. The reason for cross-connecting the fields is as follows: You know that when the field of a generator is strengthened the voltage is raised, and you also know that when the field of a motor is weakened the speed is raised. Now let us go back to the

condition above mentioned. Side A has 100 more amperes than B, hence the voltage across A will tend to be less than that across B. Now the field of motor B is connected across side A and as this is the low side the B motor speeds up, driving the machine A at a higher speed, which will naturally tend to increase its voltage. Now the voltage across B is high and the field of motor A is connected across this side and therefore this field is strengthened, tending to still further increase the voltage given by machine A. In this way the machines act automatically and up to their capacity will keep a very fair balance between the two sides of the system. A rheostat is connected in the field of each motor, so that they may be properly adjusted when in service. Sometimes the motors are compound wound, the percentage of the series field being kept very small. It is often a question whether or not the compound winding has any advantage over the shunt.

QUES. No. 4.—Would you kindly tell me what is the co-efficient of cog-wheel friction ; in other words, what percentage of the pressure upon the cogs is required to overcome the friction ?

ANS.—We must first presume in answering the above question that the cog wheels are of the plain toothed or spur type. The only data which is available upon this question refers to perfectly cut gears, properly lubricated, in perfect condition, properly meshed and supported in good bearings, and when these conditions are fulfilled the tests can be taken as correct. You will appreciate that a gear is not very long in service before practically all these conditions change, and then the friction increases greatly. An extensive series of experiments was made some years ago by Mr. Wilfred Lewis, and he has stated that when spur gearing fills the conditions named above the efficiency is 90% at a velocity of three feet per minute at the pitch line, and 98½% with a velocity of 200 feet per minute. It was found that these figures varied but little, so long as the gears were in proper shape, but that just as soon as lubrication became poor, or the wheels shifted their positions and cutting commenced, the loss became very much greater. Referring to the ordinary bevel gears used chiefly in hydraulic work, we would estimate that with wheels in good *average* condition, and having a ratio of two to one, the loss would be about 20%. These figures of course apply to the gears when operating at rated speed under normal load.

NEW POWER STATION.

The Provincial Light, Heat & Power Company will construct a new power house at Montreal to develop their water power, situated on the Soulanges Canal near Cedar Rapids. The new power plant will generate power for transmission to Montreal, and the entire output will be absorbed by the Montreal Light, Heat & Power Company. The capacity of this development will be 12,000 k.w. normal rating and all apparatus will have a large margin of overload capacity.

The specifications for the electrical equipment are being prepared by Mr. R. S. Kelsch, consulting engineer, Montreal, and will call for four 3000 k.w. 60-cycle, 3-phase, 4000-volt, Y-connected, 180 r.p.m. generators ; two 150 k.w., 125-volt, direct current generators for exciters ; 24 - 1000 k.w. 44000-volt 60-cycle transformers, together with the necessary switchboards for power house and substation.

It is expected that this power will be ready for delivery in Montreal October 1st, next, and its addition to the Montreal Light, Heat & Power Company's source of power supply will make the company's system the most reliable on this Continent. The general plans for the re-organization for the Montreal Light, Heat & Power Company's system, which are being carried out, contemplate interconnecting all steam and water power plants by means of underground cables at 12000 volts pressure, so that the failure of the power supply from any one of the six sources would not cause an interruption to the company's service.

THE TORONTO RAILWAY COMPANY.

At the annual meeting of the Toronto Railway Company held on February 7th, the following comparative statement was presented :

Gross earnings, 1905, $2,747,324.58; 1904, $2,444,534.24 ; increase, $302,790.34. Operating expenses, 1905, $1,560,437.42 ; 1904, $1,424,179.54 ; increase, $136,257.88. Net earnings, 1905, $1,186,887.16 ; 1904, $1,020,354.70; increase, $166,532.46. Passengers carried, 1905, 67,881,688 ; 1904, 60,127,460 ; increase, 7,754,228.

The company paid into the city treasury during the year a total of $405,638.89, being $292,706 as percentage of earnings, $79,996.94 on account of pavement charges, and $32,935.23 for taxes.

The old board of directors was re-elected.

According to the annual statement, the capital expenditure during the past year amounted to $507,493.79, the principal items of which are as follows : The completion of the sub-station and storage battery buildings, with plant and equipment, on Yonge street, north of Davenport Road; plant and equipment of substation at the corner of Front and Frederick streets; the purchase and laying of the underground conduit and power cables connecting the power house with the Yonge street sub-station; the construction of a number of 40-foot, double-truck, convertible cars, which have been put in operation ; others are now in course of completion ; motor equipments have been purchased for the new rolling stock; the equipment of over 100 cars with air brakes, and the installation of compressor plants in each of the car houses for charging brakes.

The large expenditures made in connection with storage batteries have been required by the increased traffic of the company during the rush hours of the day, and have already proved a great economy in the operation of the service. When the line is operated by power from Niagara Falls even greater advantages may be expected.

The City of Edmonton, Alta., is increasing the number of arc lights. This will make Edmonton one of the best lighted cities in the West.

The West Kootenay Power and Light Company, of Rossland, B.C., are applying to the Legislature of British Columbia for permission to distribute electric power in the Yale district. The application is being opposed by the Cascade Water, Power and Light Company, on the ground that the granting of such a franchise would destroy their property and annul their rights. The questions involved are of considerable importance to the district affected.

ENGINE TESTS.

An interesting official fifteen-hour test of one of the nine twin vertical-horizontal Reynolds Corliss engines, cylinders 42" and 86" x 60", which have been in operation at the 59th Street Station of the Interborough Rapid Transit Company, New York city, since 1902, was concluded December 15th. The tests were conducted by the Interborough Rapid Transit Company and representatives of the Allis-Chalmers Company as a final determination of the fulfillment of the builder's guarantee and formally provided for in the original contracts.

The following data gives a synopsis of the completed tests :

As per agreement, on account of the impossibility of keeping a constant load, the power was determined by the readings of tested integrating wattmeters. These readings were reduced to I.H.P by running the generator as a synchronous motor, adding the electrical input to the switchboard readings when developing power, to obtain the power exerted by the engine.

The result of the test so made, under conditions approximately the contract requirements of 7500 h.p., 75 r.p.m., 175 lbs. steam pressure and 26" vacuum, was a consumption of 11.96 lbs. of dry saturated steam per I.H.P. hour, or well within the guarantee of 12.25 lbs. The steam consumption per k.w. hour at the switchboard was 17.34 lbs.

Duration	15 hours.
Load	5079.2 k.w.
Friction and generator losses	417.3 k.w. = 559.41 h.p.
Total load	5496.5 k.w.
I. H. P.	7365.3 h.p.
R. P. H.	75.02
Steam pressure	175.18 lbs.
R. H. receiver	19.1 lbs.
L. H. receiver	19.27 lbs.
Vacuum	26.02 lbs. (actual)
Temp. injection water	42.36 deg.
" R. H. discharge	74.05 deg.
" L. H. "	77.38 deg.
Barometer	30.50 lbs.
Water per hour	89.906 lbs.
Drips per hour	512 lbs.
Leakage per hour (boiler)	1.470 lbs.
Boiler level correction	60 lbs.
Net water per hour	87.864 lbs.
Quality of steam	100.28%
Dry steam per hour	88.110 lbs.
Dry steam per K.W.H.	17.34 lbs.
Dry steam per I.H.P.	11.96 lbs.

The final results allow for boiler leakage, which was determined by a separate test of 24 hours duration. The steam was very slightly superheated during the test, as being easier to make allowance for than wet steam, and a correction was made to reduce the superheated steam to equivalent dry saturated steam.

The vacuum was carried at 26.02", or as near the contract requirement as possible, but the barometer stood at 30.50". The vacuum was, therefore, equivalent to only 25.52" referred to 30" barometer; no correction was made, however, as none were provided for in the contract. Other tests at varying vacua show that if the vacuum had been carried enough higher to correspond to 26" vacuum when referred to 30" barometer, the steam consumption would have been about 0.09 lbs. better, or 11.87 lbs. per I.H.P. hour instead of the official figure of 11.96 lbs.

It is probable that the Blindman Power Company will be granted an electric light franchise at Lacombe, Alta. They ask the privilege of using the streets for a term of twenty-five years and stipulate that the town shall contract for not less than six arc lights for a term of ten years at $75 per light per annum.

AMENDMENTS TO ENGINEERS' BILL.

The Central Committee of the Stationary Engineers of Ontario have decided upon the following amendments to the present Ontario Act relating to stationary engineers:

An amendment to an Act respecting Stationary Engineers, Victoria 54, Chapter 141, Revised Statues, 1897, Chapter 31, Annual 1891.

By and with the consent of the Lieut.-Governor-in-Council, and by and with the advice and consent of the Legislative Assembly of the Province of Ontario, be it enacted that this Act be amended by expunging all of it up to the words "casting vote" in section 13 thereof, and the following be inserted in lieu thereof:

1. The Lieut.-Governor-in-Council appoint a board consisting of a chairman and......members for the purpose of examining applicants and granting of certificates to all persons operating steam boilers of 50 horse-power or over.

2. It shall be unlawful for any person to operate any boiler of 50 horse-power or over unless he has a certificate, granted under the provisions of this Act.

3. It shall be unlawful for any person to employ an engineer to take charge of a boiler of 50 horse-power or over unless such person holds a certificate under the provisions of the Act, and any person who shall be guilty of operating, or any employer who shall employ any person to operate, a boiler contrary to this Act, shall be deemed to have committed a misdemeanor and shall, upon conviction, be fined not less than...... dollars and not more than......dollars for each offence.

4. Every engineer who shall be in charge of any steam plant coming under the provisions of this Act at the time it comes into force or any engineer who has had two years' experience and who applies before the expiry of one year, shall, upon proving his character and upon paying the prescribed fee, receive a certificate for the term of two years, and such certificate must be renewed from time to time as it expires, provided, however, the Board shall have power to revoke any certificate upon proof of incapacity, drunkenness or improper conduct.

5. Any person who feels himself aggrieved by the decision of the Board of Examiners, shall have the right (upon notice being given to that effect) to appeal to the Minister of Agriculture.

6. All candidates for certificates, except as provided or in section 4, shall furnish evidence of their good character, and of having at least three years' experience either as assistants in an engine room, or boiler room, or as having full charge, and shall submit to such examination, written or oral, as the Board may determine.

7. All certificates shall at all times be exposed to view in some conspicuous place in the boiler or engine room, and the failure to expose same will be prima facie evidence of the lack of qualification under the Act.

8. All fees for examination shall not exceed $...... and all renewal fees shall not exceed $......

Woodstock, Ont., is issuing $50,000 of debentures for extending the waterworks and electric light systems.

The gross earnings of the Winnipeg Electric Railway Company for the year ended December 31st, 1905, amounted to $651,650, compared with $507,542 for the previous year.

The annual meeting of the Maine & New Brunswick Electric Power Company was held at St. John, N.B., on January 23rd. This company propose to develop power from the Aroostook Falls and transmit through the counties of Victoria, Carleton and Madawaska, in New Brunswick, and in Houlton and neighboring places in Maine. The capital is $200,000. The officers for the ensuing year are as follows: President, N. M. Jones, Lincoln, Maine; managing director, A. R. Gould, Presque Isle, Maine; secretary, J. D. Seely, St. John, N.B.; treasurer, L. G. Crosby, St. John, N.B.

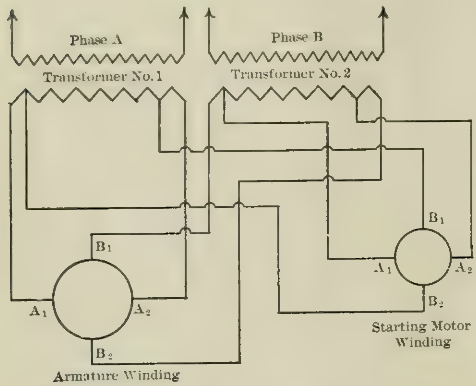
STARTING ROTARY CONVERTERS.*

There are three usual methods of starting rotary converters:

(a) By a separate alternating-current starting motor.

(b) By applying direct-current to the commutator, the converter starting as a shunt motor.

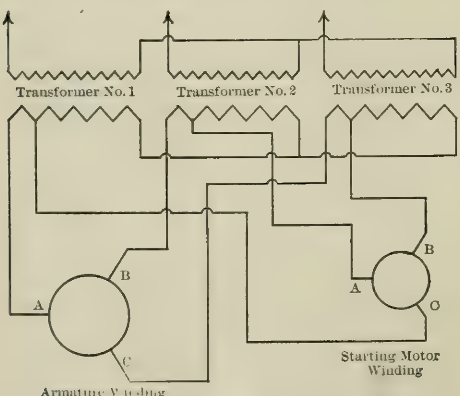
(c) By applying alternating-current directly to the



Two-Phase System.
Method for Obtaining a Lower Voltage for Starting Motor than for Rotary Converter.

collector rings, the converter starting as an induction motor.

(a) Starting with Separate Alternating Current Motor.—An induction motor is pressed on an extension of the armature shaft and this motor is used for bringing the armature up to synchronous speed. In order that the motor may bring the converter up to synchronous speed the motor is designed with a smaller number of poles than the converter and the resistance of the

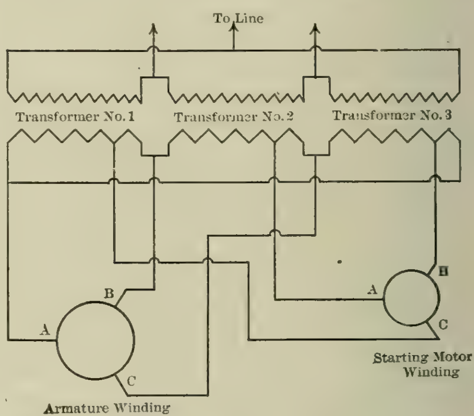


Three-Phase Y System.
Method for Obtaining a Lower Voltage for Starting Motor than for Rotary Converter.

secondary rings is made such that when running the converter at synchronous speed and with normal field excitation the motor slip will be of such a value that the running speed of the motor will be the synchronous speed of the converter. It is not essential that this adjustment of slip be made accurately. If the speed is too high the slip may be increased by lowering the voltage or by increasing the load on the motor. The latter may be accomplished by connecting a rheostat cross either the direct-current or alternating-current terminals of the converter.

With four-pole rotary converters it is not practicable to use a two-pole induction starting motor on account of the large slip that would be required. With four-pole converters, therefore, a single-phase series motor is used. Only one phase of the polyphase circuit is required for starting. This type of motor is well adapted to starting and synchronizing purposes. It gives large starting torque for small current; it has under constant conditions a definite and constant speed for a given load, but this speed for a given load can be varied over a wide range by very simple adjustment in the motor.

When the rotary converter is synchronized from the low-tension side of the lowering transformers, the starting motor may be connected to the secondary of the main lowering transformers and different voltages



Three-Phase Delta System.
Method for Obtaining a Lower Voltage for Starting Motor than for Rotary Converter.

may be obtained between different taps taken from the secondary winding. When the low-tension side of the lowering transformers is connected permanently to the alternating-current side of the converter and the synchronizing is done from the high-tension side, it is necessary to supply the starting motor by a separate transformer, since the switches in the high-tension side of the main transformers must be open until the converter is synchronized. In this case it is necessary for the starting motor to be of sufficient capacity to supply the magnetizing losses of the main lowering transformers in addition to the converter losses.

In this method the starting and operating functions are performed by separate machines; the induction motor is designed for starting and the rotary converter for operating, thereby obtaining the best possible starting performance and at the same time the best operating performance. With this method the effect of starting a rotary converter upon the transmission system is negligible. The lagging current due to starting is not more than one-sixth of the converter full-load current.

This method of starting is of wide adaptability and very satisfactory in operation. It is the method re-

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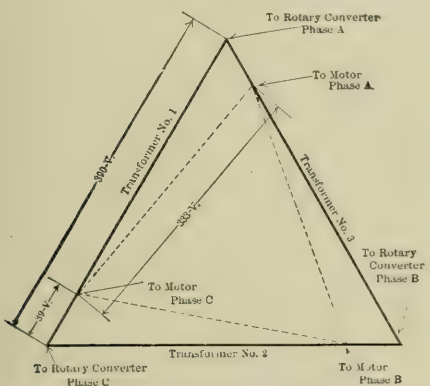
commended by the Westinghouse Company in the majority of cases.

(b) Starting from the Direct-Current Side.—For this method of starting direct-current is obtained either from the regular service bus bars or from a separate generator or circuit and the converter is started as a shunt motor. If the converter is compound wound the series field coils must be short-circuited or the starting circuit must be connected inside of the series coils in order that changes in armature current will not exaggerate the changes in speed by changing the field strength.

The operation of starting is similar to that of any shunt motor. The converter is started with strong field and resistance in the armature circuit provided by a starting rheostat. The converter is brought into synchronism with the alternating-current circuit by adjusting the speed by the field rheostat and when synchronism is reached the converter is paralleled with the alternating-current circuit by throwing in the a. c. switches in the high-tension or low-tension side of the transformers as the case may be.

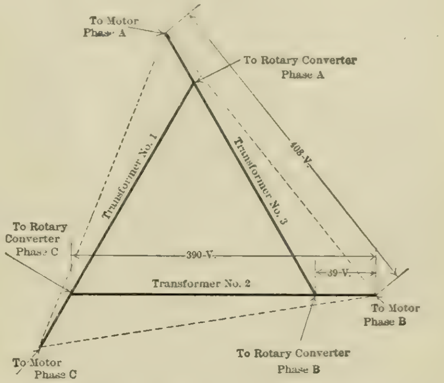
Certain difficulties have shown up in practice with



Three-Phase Delta System.
Diagram Showing Connections for Obtaining a Lower Voltage for Starting Motor than for Rotary Converter.

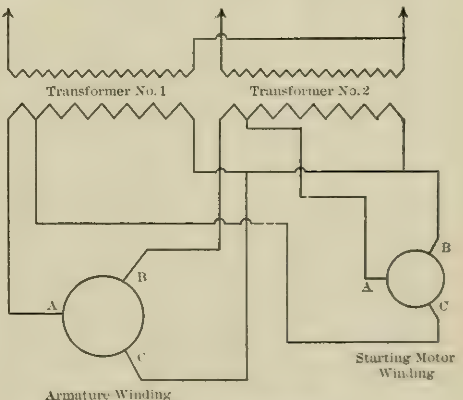
this method of starting but these difficulties have been in general due to the characteristics of the converter itself and to unsuitable starting devices. The principal difficulty is that when the converter is brought up to practically synchronous speed any slight variations in the direct current voltage tend to produce corresponding variations in speed, thus changing the frequency at the alternating current end of the converter. On account of this, the synchronizing period may become so short that an ordinary operator cannot throw the switches quickly enough to insure proper paralleling. Another difficulty is that if the converter is slightly out of its true synchronous position when the alternating current switches are closed there will be an excessive interchange of current between the alternating and direct current sides of the converter.

Both of these difficulties are due to the low resistance of the armature circuit of the rotary converter. They may be overcome by inserting in the starting circuit a permanent resistance that will limit to a relatively insignificant amount the current due to ordinary changes in armature voltage. An example will serve to show the truth of this. Assume, first, a 1000 k.w. rotary converter wound for 600 volts on the direct current side and with a normal current rating of 1666 amperes. The resistance of the armature winding will be such that about 10 k.w. will be lost in the winding with full load current as a direct current machine. In other words, the resistance of the armature windings is such that six volts is required to drive full load current through it. Assuming that this converter is running in synchronism with the alternating current system, but not in parallel with it, a sudden change of six volts in the e.m.f. applied to the armature would mean a



Three-Phase Delta System.
Diagram Showing Connections for Obtaining a Higher Voltage for Starting Motor than for Rotary Converter.

tendency to a momentary rush of 1666 amperes through the converter armature. This current, if it should actually flow, would almost instantly change the speed of the converter, and the action would be so rapid that the change in speed would occur before the alternating current switches could be closed, if it happened that the operation of paralleling was being carried on at this instant. The converter would there-



Three-Phase V System.
Method for Obtaining a Lower Voltage for Starting Motor than for Rotary Converter.

fore go in parallel with the alternating current system when not properly in phase and whether the machine would pull itself in step or momentarily fall out of step would depend upon its inherent characteristics. In any event there would be a heavy rush of current from both the alternating and direct current circuits through the converter armature. The current that would flow from the direct current circuit would be largely determined by the armature resistance so that with the low

armature resistance in the assumed rotary converter the current would be large.

Assume in the second place that when the same rotary converter is brought up to synchronous speed, one ohm resistance is left in circuit between the converter armature and the direct current supply circuit. This would represent the opposite extreme condition. As approximately forty amperes will be sufficient to maintain the converter at speed under these conditions this additional resistance will cause only a relatively small drop in voltage. Assuming, as in the first case, a change of six volts in the bus bar voltage, the change in current to the converter will be six instead of 1666 amperes. With this small current the change in speed due to change in voltage will be entirely due to the consequent change in field strength and this will occur slowly, so that it will be comparatively easy to synchronize the converter with the alternating current system even with a fluctuating direct current voltage. Furthermore, should the converter be paralleled when not exactly in synchronism, while a large current will flow from the alternating current circuit as in the first case in order to bring the armature into synchronism, only a small current will flow from the direct current side on account of the resistance left in the starting circuit. It should also be noted that with the resistance in the starting circuit it is not necessary to have the voltage of the converter and of the alternating current circuit the same when they are parelleled. If they are different it will only require a comparatively small corrective current from the alternating current circuit to equalize them and the resulting change in the direct current voltage of the converter will not cause a disturbance in the direct current circuit, since the resistance in the starting circuit will limit the current resulting from this difference between the direct current voltages of the machine and circuit. For this reason it is possible to employ this resistance even when the voltage of the bus bars is the same as or even less than the voltage necessary to make the alternating current voltages of the converter and of the alternating current system the same.

A rotary converter of low armature resistance in connection with a low resistance starting circuit will be very sensitive to changes in voltage ; the changes in speed will be large and will occur quickly. Synchronizing will be correspondingly difficult. With a starting circuit of relatively large resistance the same converter will be sluggish ; changes in voltage will have comparatively little effect on the converter speed and synchronizing will be comparatively easy. In either case, however, paralleling will not be uniformly successful unless the design of the rotary converter is such that it will pull into step even if the switches are closed when the converter is not exactly in synchronism.

It is evident that with a rotary converter of suitable design and with a starting circuit of suitable resistance, starting from the direct-current side is entirely satisfactory. This is true whether the source of direct-current is the service bus bars or a separate starting generator.

The preceding discussion refers particularly to the use of the service bus bars as the source of power for starting. When a separate starting generator is used the conditions are of the same nature but are more favorable. There will be little fluctuation in the voltage and it can be readily adjusted to the necessary value so that suitable phase relations and voltage conditions can be obtained without difficulty. The starting generator is made shunt wound. This is done in order to obtain a drooping voltage characteristic which gives results very similar to those obtained by a resistance placed between the converter armature and the bus bars. Any increase in load on the starting generator will cause a drop in voltage at its terminals ; any decrease in load will cause an instant rise in voltage. Therefore, if there be any tendency to a rush of current between the alternating and direct current circuits at the instant of paralleling, the natural voltage characteristics of the starting generator will prevent its occurrence. There will be no flashing at the commutator of either the rotary converter or the starting generator.

With this method of starting by direct current the converter may be permanently connected to the low-tension side of the transformers and paralleling done by means of switches in the high tension line. When this is done it will require more current to start the converter than if the transformers were entirely disconnected. The increase in starting current will vary with converters of different number of phases. In a two-phase converter the entire armature winding may be paralleled by the transformer coils. The increase of current will be governed by the relative resistances of the two circuits, but in general it will be so great that it is not feasible to start a two-phase converter with the transformers connected. This increase in current exists only at the instant of starting ; as the converter begins to revolve alternating current flows in the transformer secondary and the self induction limits the current to a negligible value. Therefore the switches in the low tension transformer circuit may be closed at any time after the converter starts, provided, of course, there are also switches in the high tension circuit, which is generally the case.

With a three-phase converter only a part of the armature will at any time be paralleled by the transformers and the current shunted from the armature will be correspondingly less. It is feasible to start with direct current with the transformer secondaries connected and three-phase converters are often installed in this way. The increase in starting current due to the transformers will depend on the characteristics of individual converters and transformers but as an approximate rule it may be stated that with three-phase rotary converters the starting current will be increased 100 per cent. when the transformer secondaries are connected to the armature. With the transformers disconnected it will require roughly 8 per cent. of the rated full load current for starting and with the transformers connected it will require about 15 per cent. It should be understood that these figures are very approximate. Too much dependence should not be placed upon them as they will vary considerably in individual cases.

With a six-phase rotary converter and with the secondaries of the transformers connected across diametrical points of the armature winding the conditions of starting with the transformers connected to the converter are much the same as with a two-phase converter ; it is not considered practicable to start the

converter with the transformers so connected. With the transformers connected in the more usual double-delta the same starting conditions exist as with the delta-connected three-phase converter and the results will be similar.

(c) STARTING FROM THE ALTERNATING CURRENT SIDE.—In this method the alternating current side of the converter is connected to the alternating current circuit, the direct current switches being open. Under these conditions the rotary converter starts as an induction motor, the armature acting as the primary and the field poles as the secondary. The field winding plays no part in starting, as it is open circuited in several places, by means of a break-up switch usually located on the side of the frame of the machine. It is necessary to open up the field winding into several sections in order to limit to a safe value the voltage induced in it by the rotating magnetic field set up by the polyphase current in the armature winding.

This method of starting rotary converters is objectionable for two important reasons :

(1) For good running characteristics a rotary converter must have an armature of small self-induction and have field poles provided with copper dampers. Both of these are antagonistic to economical starting when the starting is done with alternating cnrrents in the armature winding. The result of this is that when a rotary converter is designed for self-starting from the alternating-current side, good running characteristics are sacrificed in order to obtain relatively good starting characteristics; the armature is made stronger and dampers are made in a less efficient form than would be the case if running characteristics were alone considered.

(2) The best starting performance that can be obtained by this method is a starting current ot from 1¼ to 1½ full-load current at a power tactor of from 20 per cent. to 30 per cent. Even with the minimum starting current and maximum power factor, these figures mean a lagging component of the current greater than full-load current. The effect of this lagging current on the voltage of the generator is such that it requires a generator two or three times the capacity of the rotary converter to start it, providing it is necessary to maintain the voltage. Even with large generator capacity the drop in voltage when a converter is started may be great enough to cause other converters operating on the same circuit to fall out ot step, especially if they are heavily loaded.

It is claimed for this method that it results in rapid synchronizing. This is true for a single converter if the converter falls in step with the right polarity at the first trial. With a number of converters in the same system (and this is practically always the condition), it is not true, because only one converter can be started at a time on account of the large current required.

The Armstrong Light & Power Company have been given a franchise by the citizens of Armstrong, B.C. It is proposed to develop a water power at Davis Creek and to supply the entire municipality of Spallumsheen with electric light and power. The scheme also embraces tramways and telephones.

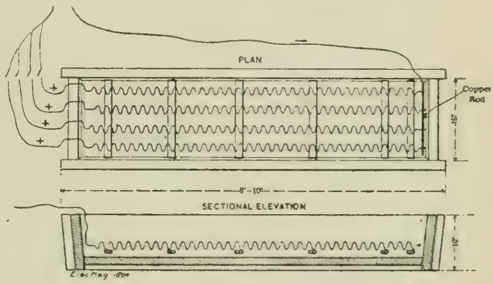
The British Columbia Electric Railway Company recently completed a snow plough which is somewhat unique. It is of the usual railway pattern, but the platform of the car is so arranged that by means of a king pin the whole car can be swung round clear of the tracks and turned round, thus doing away with the turn table. This will be of inestimable advantage in a severe storm.

A SIMPLE AND EFFICIENT RHEOSTAT.

Many engineers know the little troubles connected with rigging up a temporary water rheostat for taking up a load while testing engines. Barrels and plates are usually employed, and a very usual weakness lies in the boiling of the water, and the consequent rapid fluctuation of the load, which always depreciates the engine performance. It is also generally necessary to use salt in the water, and too much of this will put the rheostat out of control. In the illustration, reproduced from the American Electrician, is shown a diagram of a rheostat in which galvanized iron wire, immersed in pure water, is used. The one in question absorbed a load of 100 kilowatts for nine hours continuously, with less than 1 per cent. fluctuation, the final adjustment being obtained by controlling the inflow of circulating cold water, which simply overflowed the trough.

There were four coils used, which were all connected at one end to a copper rod. The other ends were each operated by switches so that approximately quarter, half, three-quarters, and full load could be obtained at will. Two of the coils were of No. 14 B. & S. gauge, 180 feet long, and were made by winding on a 1¼ in. arbor. The remaining two were made of No. 16 B. & S. gauge and were 150 ft. long.

The receptacle in this case was a common horse



A SIMPLE AND EFFICIENT RHEOSTAT.

drinking trough, and the coils were laid on a number of supporting cross-pieces. As there was a 3 in. clearance between each coil there was no tendency to touch. Accompanying this is a table giving the data concerning the carrying capacity of iron wire under water.

CARRYING CAPACITY OF GALVANIZED IRON WIRE IN WATER.

B. & S. Gauge.	Amperes.	Feet per 110 volts.	Feet per 550 volts.	Feet per pound.
20	36	25		309
19	42	27	—	293
18	50	29	—	232
17	60	30	—	164
16	71	32	—	146
15	88	34	—	107
14	103	36	—	91.9
13	122	38	—	72.1
12	145	40	200	57.8
11	173	42	210	45.8
10	205	45	225	36.4
9	245	47	235	33.3
8	293	58	290	25.0

Under the able management of Mr. John Yule, the electric and gas lighting plants at Guelph, Ont., are making a very satisfactory showing. Owing to the installation of a new engine and dynamo last year, the electric plant was enabled to carry a much larger amount of business, with the result that the reduction in electric light rates was more than offset by the increased business, the increase over 1904 being 42 per cent. in business and 13 per cent. in receipts. The net gain for the six months of both electric and gas plants shows only a decrease of $240 over that of 1904, the reduction in rates being offset by the increase in electric and gas heating business.

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
38 Alliance Building, MONTREAL.

February 9th, 1906.

The daily press have announced several fires here lately due to electric wires. St. Paul's church, for instance, where the wires, according to a contemporary, were seen "spouting flames", was traced to a defective flue in connection with a hot air furnace; the wiring of that installation, made 13 years before and "old style", was intact and had nothing whatever to do with the fire. Another fire put down to electric wires at the Coristine Building took place in a bundle of rags, etc., several feet distant from the nearest circuit. The nearest hit to an electric fire that has been made was one caused by an electric wireman, who upset his gasoline soldering lamp and set fire to the premises. The firemen are naturally antagonistic to exterior electric wiring and take this means of filling the heads of reporters to get the wires put underground, but their efforts merely seem to strike the interior wiring contractor and that unjustly.

The Montreal Street Railway Company claim to obtain an increased percentage of fares by the "pay-as-you-enter" style of car. This is not to be wondered at when the said car has considerably more seating capacity than the old ones. They do not mention the increased percentage of odium than is thrown at them by the ladies for this ungallant treatment in cold or rainy weather. It is to be hoped that the Mayor of Toronto who paid attention to these cars has satisfied himself that the "game is not worth the candle" and that Torontonians will not be burdened with this so-called invention.

The Quebec License Act does not seem to stop occasional visits from our various American friends in the trade. It is to be hoped that they will continue visiting us, as the petty legislation is disliked on both sides.

The municipal plant of the town of Westmount is beginning to show something; the power building is well under way and poles are being planted throughout the town. There is no question that the plant will be pushed to completion and will prove in time a serious competitor to the Montreal Light, Heat & Power Company in that district.

Trade in Montreal with electrical contractors has been much better so far this winter (probably due to the mild weather) than in the last couple of winters; in fact, if there had been 90 per cent. less contractors the balance would have been comfortably busy.

The old Electrical Contractors' Association is no more, but the bulk of its members have affiliated themselves with the Builders' Exchange and are known as the Electrical Section. Their representative on the Board of Directors is Mr. Wm. B. Shaw, of the Montreal Electric Company, who advises us that he will be glad to hear from any of the members who have any points which they wish brought up before the Exchange.

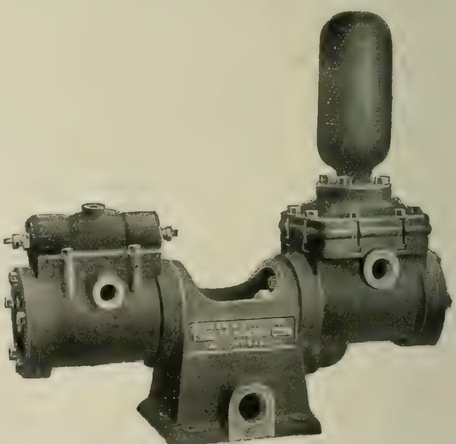
Inspection of electric wiring in Montreal is in a strange condition. At a meeting held in the rooms of the Civil Engineers' Society recently it was publicly stated that there is a by-law on the city's books calling for inspection, and yet the city have provided no inspector, stating that it is the place of the Underwriters to do so; the Underwriters on the other hand seem to have such small losses from electrical fires that they do not deem it worth their while to pay a salary to an inspector. The whole inspection devolves on the Lighting Company refusing to make connection unless the installation is in accordance with their views, and although on the whole it may be said their decisions are fair, yet they tend to bring the question of life more into prominence than fire. It is a question if there is any other city on this continent of the same size where such a mixed condition of affairs exists.

Architects seem to have got it into their heads that "iron conduit" is a cure for all ills in interior electrical wiring. Perhaps some of these days the use of iron pipe in buildings using wood in their construction will surprise them. At a recent meeting of the Engineers' Society this very qnestion was ably handled by Mr. R. A. Ross, E.E.

STEAM PUMPS.

There is possibly no more annoying feature about a steam plant than a poor pumping service, an efficient or worn-out pump being a source of great annoyance to say nothing of the danger. The Goldie & McCulloch Company, Limited, of Galt, Ont., have given much attention to the manufacture of boiler feed pumps and are now furnishing pumps which are absolutely reliable and will give efficient, constant and effective service. All moving parts are inside, protected against injury, but are easily accessible.

The illustration herewith give a general view of the pump. The base being cast hollow forms a suction chamber, to which the suction pipe may be attached on either side. The steam and water cylinders are both attached to this base, both overhanging. This arrangement permits the cylinders to be removed for inspection or for repairs. A large and expensive foundation is not required, as pump is self contained.



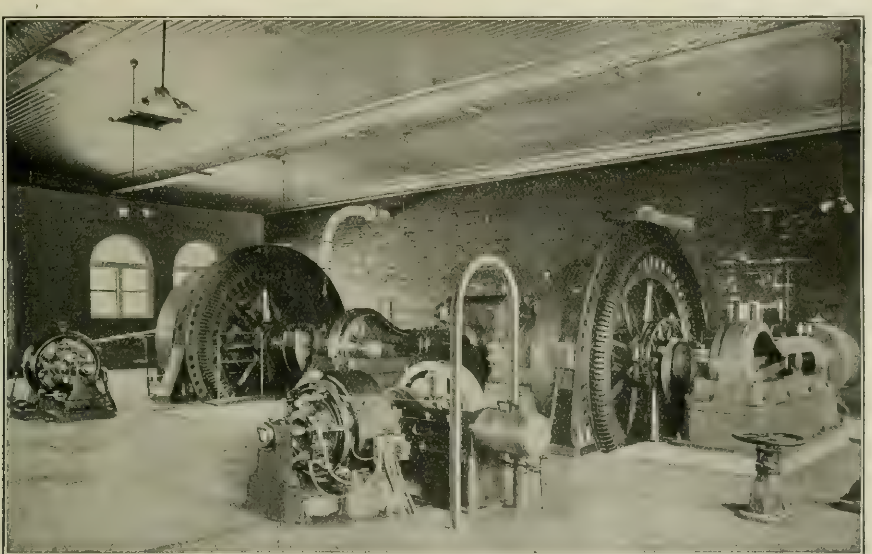
GOLDIE & MCCULLOCH STEAM PUMP.

The best material and workmanship are employed throughout. The water cylinder lining, valves and seats, rod box glands, nuts, etc., are brass. The piston rods are Tobin bronze or Muntz metal, which will neither tarnish nor corrode. These do not cost extra, but are on their regular lines. The pump cylinders are provided with a removable brass lining that can easily be taken out for re-boring or exchange.

THE EDMONTON ELECTRIC PLANT.

The new and thrivingcity of Edmonton, Alberta, towards which the three great railway systems of Canada are now racing, is already prepared to light them on their way to the Pacific. Though 400 miles farther north than Winnipeg, it has a well equipped municipal lighting plant of the latest type. The illustration here shows the interior of the power house.

The plant, which was installed by Allis-Chalmers-Bullock, Limited, of Montreal, consists of two engine type generators, 2400 volts, 3 phase, 60 cycle, 150 r.p.m. The generator shown near the window is of 450 k.w., driven by a 600 h.p. cross compound horizontal Corliss engine. The smaller generator shown in the foreground is of 225 k.w. driven by a smaller engine of 350 h.p. The exciter plant consists of a 22½ k.w., 450 r.p.m. generator capable of exciting both of the large generators, belted to the engine shaft which drives the larger of the two, and a 25 k.w., 350 r.p.m. generator direct connected to a 40 h.p. engine. The contract with Allis-Chalmers-Bullock, Limited, Montreal, also included switchboard and all necessary accessory equipment.



INTERIOR OF POWER HOUSE, EDMONTON, ALBERTA.

This lighting plant, though exceeded in size by some, is perhaps not equalled for efficiency and general layout by any in Canada.

CHANGE OF CONTROL.

The entire stock and assets of the Brantford Electric & Operating Company, Limited Brantford, Ont., have been acquired by the Western Counties Electric Company, who have been negotiating for some time for a franchise in Brantford. The newly elected president of the Brantford Electric & Operating Company is Mr. John Knox, of Hamilton. Mr. A. T. Duncan, formerly manager of the Lincoln Electric Light & Power Company, St. Catharines, is managing director. Mr. Louis W. Pratt, who for a number of years has been president and secretary-treasurer of the company, will be retained in the same capacity.

It is said to be the intention of the Western Counties Electrice Company to make extensive improvements. A steam auxiliary plant will be installed as well as modern arc lamps. It is also proposed to extend the lines to neighboring municipalities. The company are said to have in view the bringing of Niagara power to Brandford and making that city a large distributing centre.

OTTAWA ELECTRIC RAILWAY COMPANY.

The shareholders of the Ottawa Electric Railway Company held their annual meeting a few days ago. A statistical statement of the company for the years 1891 to 1905, inclusively, was read, showing that the business has increased steadily year by year since the electric road was started. The business of the old horse car company was also referred to, and a comparison between the business of that company and of the electric railway is most interesting. For instance, in 1885 the Ottawa city passenger railway (horse cars) carried 383,720 passengers and earned $19,186; in 1895 the Ottawa electric railway carried 4,583,000 passengers and its receipts were $212,000; while in 1905 the number of passengers carried was 9,891,000, and the receipts were more than doubled, being $449,633. The net profit for the year was 14 3/10 per cent. Of this amount 10 per cent. was paid in dividends and bonus, and the balance, $44,000, was applied to the reduction of the plant and profit and loss accounts.

It is claimed that the percentage of profit of the past year's business is the best ever shown by a street railway in Canada, the Montreal Street Railway Company in their last published annual report showing a percentage of only 11¼ per cent.

The following were elected directors for the current year: T. Ahearn, Peter Whelan, Warren Y. Soper, Hon. George A. Cox, George P. Brophy, Thomas Workman. The directors subsequently elected the following officers: President, T. Ahearn; vice-president, Peter Whelan; secretary-treasurer, James D. Fraser.

TELEGRAPH and TELEPHONE

BELL TELEPHONE APPOINTMENTS.

Important changes in the management of the Bell Telephone Company of Canada were announced last month. Mr. L. B. McFarlane has been appointed general manager, and Mr. C. F. Sise will practically retire from the active management of the company, although he will continue to act in an advisory capacity and retain the position of president. Mr. C. F. Sise, jr., has been appointed general superintendent; while districts No. 3 and 4 ot the Ontario department will be combined under Mr. J. L. Richmond, district manager, and Mr. W. H. Hayes has been named district manager for Manitoba and Saskatchewan.

Mr. L. B. McFarlane, who was formerly general superintendent, has been connected with the company since its inception in 1880, when he was appointed manager of the Eastern department. Ten years ago he was made general superintendent, and he now receives a further promotion in recognition of his ability and long service.

LEGAL DECISIONS.

Judgment has been rendered in the Court of Review, Montreal, in the case of the Bell Telephone Company vs. the Canadian Asbestos Company. The suit arose over the insertion of the name "Canadian Asbestic Company" in the telephone directory by one Dickson Anderson, a dealer in asbestos. The Asbestcs Company alleged that the use of a name so similar to theirs would cause them damage, and obtained an injunction against its use on giving certain security for the cost of the erasure. This suit is to recover $228, $151 of which are for the expenses of erasing the name, and the balance, $77, for services of counsel.

The first court dismissed plaintiff's action on the ground that they could obtain damages only from Dickson Anderson, who had caused the insertion.

Mr. Justice Tait gave as his judgment: "The majority of the court are to reverse and condemn defendant to pay plaintiff the $151 expenses incurred in erasing the name, etc. We do not think it is responsible for the $77. The defendant is, of course, condemned to the costs of both courts."

Mr. Justice Doherty dissented from the above judgment and declared that plaintiffs did only what they were obliged to do in erasing from their directory a name which would injure the defendants, and therefore had no right to receive payment for their expenses in so doing. He considered the dismissal of their suit by the judge who sat in the first instance as perfectly justified.

SHORT-CIRCUITS.

The Bell Telephone Company have purchased property in East Toronto on which to build a new exchange.

Mr. R. S. Kelsch, E. E., Montreal, has been engaged to report as to the best telephone system for the town of Edmonton, Alta.

The Nova Scotia Telephone Company have purchased a site at Amherst, N.S., on which it is proposed to erect a brick or stone exchange.

Plans have been prepared for a new telephone exchange to be built by the Electric Railway, Light and Power Commissioners of Port Arthur, Ont.

The New Brunswick Telephone Company have decided to construct a new copper circuit between Fredericton and St. John and between Canterbury and St. Stephen.

The New Brunswick Electric Telegraph Company have accepted the offer of the Western Union Telegraph Company to renew their lease for fifty years on an 8 per cent. basis.

The Conrad Telephone Company is seeking incorporation to operate a telephone system at Dawson, in the Yukon territory. Mr. Robert Kelley, of Vancouver, B. C., is one of the promoters.

The Dinorwic & Gold Rock Telephone Company has been organized by Mr. Archie Campbell and will operate between Gold Rock, Wabigoon, Dinorwic, Dryden and the Grand Trunk Pacific main line.

Mr. D. Upper, for the past four years manager at Victoria, B.C., for the Great Northwestern Telegraph Company, has secured leave of absence for several months. Mr. F. W. Bowes has been appointed acting manager.

The 59th annual meeting of the Montreal Telegraph Company was held in Montreal last week, at which the old board of directors and officers were re-elected. The annual report showed the gross assets of the company to be $2,288,000.

Mr. B. S. Jenkins, general superintendent of C. P. R. Telegraphs, Winnipeg, has received word that an appropriation of $250,000 for the construction of lines west of Lake Superior has been authorized. This money will be used solely for new lines.

Tenders will be invited this month for the new block to be built at Vancouver, B.C., by the British Columbia Telephone Company. The building will be three stories, with a large basement, and thoroughly fireproof, the construction being of iron, steel and concrete.

Notwithstanding that the Bell Telephone Company have 85 exchanges and toll offices now in operation in Manitoba, 30 more are to be established. The rural service will be greatly extended during the coming season and hundreds of farms will be connected with the company's system.

The Welland County Telephone Company is being incorporated for the purpose of building and operating a telephone system in the county of Welland. The provision directors are Messrs. John Pierson, S. H. Tripp, C. Glenny, Thomas Glenny, P. A. Storm, W. Robinson and C. E. Seauer, of Bertie Township.

In the general development of the telegraph art the old primary battery is being displaced, and its place taken by storage batteries and dynamos. Attention is being paid to improving the older and less efficient apparatus, and overhead lines are being made stronger and better adapted to resist the stresses of the weather.

Plans have been approved at the head office in Montreal for the improvement and extension of telegraph lines on the Pacific division of the C.P.R. An iron wire is to be strung between Vancouver and Ashcroft and a copper wire between Ashcroft and Revelstoke. The line between Nelson and Castlegar, built in 1895, will also be standardized. A copper telephone circuit will be installed connecting all the C.P.R. hotels in the Rockies, comprising those at Banff, Laggan, Field, Emerald Lake and Lake Lousie Chalat. In this work 126 miles of line will have to be built.

A method of ascertaining the depth of water by means of the telephone is being employed in the German Navy, says the Deutsches Offizerblatt. Sound waves are given out which disperse in all directions at a known rate of speed. Those which strike the ground at the bottom of the water are reflected, and the times of their dispatch and return to the instrument are recorded. The velocity of the sound wave being known, it is easy to calculate the distance traversed. It is needless to say that the recording instrument has to be extremely sensitive and delicate in order to give records of any value.

Mr. T. T. Simpson, C. E., Ottawa, is preparing plans for a new hydraulic and electric plant for the town of Parry Sound, Ont. Specifications will be ready shortly.

The end of the famous street lighting question at Ingersoll, Ont., has been reached, and under the new contract, which will date from July 1, 1906, the Ingersoll Electric Light & Power Company will furnish 45 arc lights all night for $2,500 per annum. In the meantime the present contract will be continued.

The British Columbia Electric Railway Company will build probably 20 new cars this yearin their shops at New Westminster Eight double-truck cars will be built for Vancouver, these to be of the semi-convertible type, finished in mahogany, rosewood, ash and maple. A large car with powerful motors will be con structed for freight service, and fou 20-ft. single-truck cars and two double-truck cars of the Kitsalano type will be built for service on the Victoria city lines.

CANADIAN
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VOL. XVI. MARCH, 1906 No. 3.

WATER POWER DEVELOPMENT AT CLARKE CITY, QUE.

The prediction that some day the provinces of Ontario and Quebec will be the manufacturing centre of North America would soon be removed from the category of prophesy if the development which is now taking place at Seven Islands, in the province of Quebec, should provide the stimulus for similar industries at other points. The works under construction at Clarke City, the name given to the yet primitive village, are of such a colossal nature as to daunt the courage of any but those having unbounded faith in the country and in the general proposition. Up to the present the public has heard but little of this water power development and pulp mill enterprise on which nearly $2,000,000 has already been expended, and the illustrations and particulars presented in this number of the CANADIAN ELECTRICAL NEWS will doubtless be of interest.

The promoters of this undertaking are the North Shore Power, Railway and Navigation Company, incorporated by special act of the Dominion Parliament on May 15th, 1902, with headquarters in Quebec City, offices at New York and Toronto, and works at Clarke City, Bay of Seven Islands, on the north shore of the Gulf of St. Lawrence. The officers and directors of the company are: President, James Clarke, publisher, New York; first vice-president, William Clarke, contractor, Toronto; secretary-treasurer and resident director, Thos. Meaney, Quebec; Directors, George Clarke, publisher, New York, and John Clarke, contractor, Toronto.

The work is being carried out under the supervision of Engineers Ross & Holgate, of Montreal, and George F. Hardy, of New York, while F.W. Spicer is general manager of construction.

NORTH SHORE POWER, RAILWAY AND NAVIGATION COMPANY—GENERAL VIEW OF WORKS UNDER CONSTRUCTION AT CLARKE CITY, QUE.

Construction operations commenced in the spring of 1902 and since that time the company have completed and equipped with full complement of rolling stock a standard gauge steam railway nine miles in length extending from the harbor of Seven Islands to the town site of Clarke City, in addition to saw mill, pulp mill, machine shop, and other buildings described below and shown in the illustration on this page. The town site, consisting of 3,000 acres, occupies a level plateau, elevated about 165 feet above the level of the river, and on it are situated the following: Railway yards; storage yards for lumber, logs and pulp wood; large saw mill fully equipped with modern machinery; store house 280 x 72 ft.; concrete boiler

house 76x53 ft. equipped with six 150 h. p. boilers; concrete engine house; concrete building 90 x 40 ft., two stories, for wood preparing department; concrete buildings for machinery repairs, etc., consisting of machine shop 113 x 40 ft., equipped with all requisite modern machinery and tools, locomotive shop 80 x 30 ft. and machinery supply room 80 x 30 ft. The large general stores building is also of concrete.

The development of the water power and erection of pulp mill was commenced in the spring of 1904, Mr. H. J. Bishop, of Toronto, being superintendent of this part for the company and having designed the lay-out of plant and equipment, including the coffer dams, mechanical apparatus, etc., required in carrying out the work. The water power under development is situated on the St. Marguerite river. The work entails about 18,000 yards of rock excavation and some 8,000 yards of earth excavation (exclusive of materials used as fill for temporary coffer dams), and will require approximately 28,000 cubic yards of concrete to complete. The dam consists of a head gate wall 485 ft. long, varying from 32 to 48 ft. high, and an overflow dam 690 ft. long, 405 ft. averaging about 22 ft. high and 285 ft. averaging about 10 ft. 6 in. high. The working head of water will be 53 ft. There are seven penstocks for conveying the water to the turbines, four being 15 ft. in diameter, one 8 ft. in diameter and two 7 ft. 6 in. in diameter, controlled by 30 headgates. The turbines, which will have a combined capacity of about 22,400 h.p., were manufactured by the S. Morgan Smith Company, of York, Pennsylvania.

North Shore Power, Railway and Navigation Company—Main Coffer Dam.

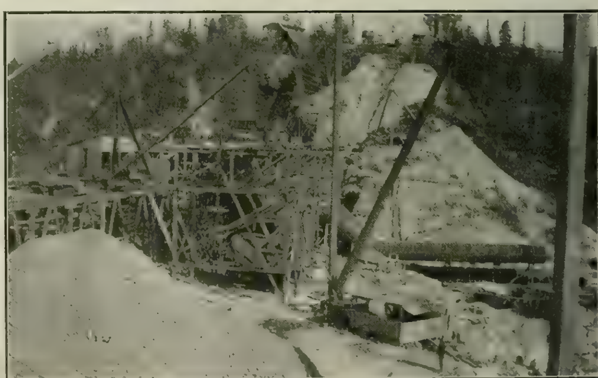
The pulp mill building when completed will be 500 x 160 ft. and will have a capacity for turning out 250 tons of dry mechanical pulp per day. It is expected to be in operation during the current year. The pulp grinding equipment will consist of 48 grinders, taking a total of 18,000 h. p. There will be an inclined railway connecting the mill with the machine shop (which is 160 ft. above the level of the mill), and a complete system of conveyors for handling logs, pulp wood and pulp. The electric plant for power purposes will consist of eight 100 kilowatt generators, the contract for which has not yet been awarded.

In addition to the works completed and under way, the plans of the North Shore Power, Railway & Navigation Company include the construction of a large box shook factory and various other enterprises, which it is estimated will involve an outlay of $5,000,000.

FEATURES OF CONSTRUCTION.

When the company started operations they found Clarke City a real wilderness, and up to the present time the timber cut on their lands has been used entirely in the construction of their various buildings.

The condition of the St. Marguerite river was such as to necessitate much work in preparation for the construction. To divert the river it was necessary to construct two large crib coffer dams, one being about 400 ft. long and varying from 8 ft. to 23 ft. in height, and the other (the main dam) being about 300 ft. long and averaging about 24 ft. in height. The cribs for the main dam were built about 24 ft. square and from 12 to 16 ft. deep and were sunk in water running at about eleven miles per hour. Stone and clay were used for filling the cribs, on which was built a continuous crib-work up to the required height. This crib-work was also filled with stone, after which sand and gravel were dumped on the upstream side of the dam until the whole was made water tight. In addition, about 400 feet of small crib protection dams were built, and an earth dam about 500 ft. long and 10 ft. high was carried across a bay of the river so as to permit of the unwatering of the site of the mill and tail-races. This bay from which the water was pumped was some eight acres in extent.



North Shore Power, Railway and Navigation Company—Portion of Head Gate Walls, Showing Methods of Operation.

The foundations of the mill are carried down to solid rock at some points extending 20 ft. below the bed of the river. The rock excavated is all granite, of excellent quality for concrete work, and all of which will be used.

Two large stone crushers, manufactured by the Jenckes Machine Company, of Sherbrooke, Que., break

the stone on the site of the mill and dam. The sand for the mill concrete is excavated from the bed of the river, being loaded direct into small cars and hauled up an incline track to the concrete mixer. Sand for the dam is excavated on the line of the company's railway and hauled on cars to a trestle at the brink of the mill, being carried down to the required point by a link belt conveyor furnished by Carrier, Laine & Company, of Levis, Que. The cement and other materials are conveyed down an inclined railway, the tracks continuing along on top of the concrete forms of the dam.

North Shore Power, Railway and Navigation Company—South Wall of Mill, Tail Races and Portion of Head Gate Wall.

Two Smith concrete mixers, furnished by W. H. C. Mussen & Company, of Montreal, are used. The mixers empty into small dump cars in which the concrete is conveyed to the desired location and dumped direct from cars into forms. The cars are so arranged that they can be lifted by derricks and transferred from one track to another or from one level to another. Six large guyed derricks, two stiff leg derricks, and two travelling derricks on trestles, cover the whole of the site of the mill and headgate wall, whilst a locomotive crane handles the materials in the yard above and passes them to the inclined railway. Materials or machinery can consequently be easily moved about to any point required.

A trestle 22 ft. high extends the full length of the headgate wall, and upon this a large travelling derrick with 54 ft. boom, and a Smith concrete mixer with double deck travelling platform, can be moved backward and forward as required.

The stone crushers have belt conveyers attached which convey the stone into bins, from which it is conveyed by small dump cars direct to the concrete mixer. In forming the walls and dams, heavy trestle bents are built to full height (conforming to the section) and set up at intervals, which bents support and stiffen the framework of forms and also support the stringer upon which the tracks are laid for the cars which carry the concrete and dump directly into forms.

The plans of the company for the no distant future include the development of their extensive mineral deposits of iron, copper, gold, mica, asbestos and limestone. It is proposed to employ a special electrical process for the treatment of the iron ore and sand.

AN ALLIED COMPANY.

The directors of the North Shore Power, Railway & Navigation Company form the same board as the Quebec, Saguenay & Gulf of St. Lawrence Railway Company, which latter company has secured a charter from the Dominion Parliament for the construction of a standard gauge railway from Quebec to Seven Islands. The preliminary surveys of this line show approximately a road of some 375 miles. For the first 200 miles of this road, the Dominion Parliament has voted the usual cash subsidy. The company is now in treaty with the Provincial Government for a land grant, which when obtained will result in the construction of this very important and much needed line. The construction of this road means the building of large terminals at Quebec and Seven Islands. Seven Islands will then become one of the greatest winter ports in Canada.

THE EDMONTON ELECTRIC PLANT.

Referring to the electric plant recently installed at the city of Edmonton, Alberta, described and illustrated in our issue of February, 1906, we are informed that the 600 h.p. cross compound engine referred to is of the Robb-Armstrong Corliss type, and the smaller one is of the Robb-Armstrong "Sweet" valve type, manufactured by the Robb Engineering Company, Limited, of Amherst, Nova Scotia. In addition, the Robb Engineering Company previously installed in the same plant a 150 h.p. engine, 30 h.p. exciter engine and two 150 h.p. Robb-Mumford boilers, the steam part of the equipment having been furnished and installed by this company.

North Shore Power, Railway and Navigation Company—Buildings in Course of Construction.

The Electrical Equipment of Joseph Simpson Sons' Knitting Mills

The electric light and power plant recently installed in the knitting mills of the Joseph Simpson Sons' factory in Toronto, under the supervision of Mr. H. F. Strickland, electrical engineer, and now chief electrical inspector of the Canadian Fire Underwriters Association, is a 250 k.w. three-phase 550 volt installation and is the outcome of a 3 k.w. Edison bi-polar dynamo and wiring for 40 lights installed as an experiment in the finishing room of this factory over seven years ago by the same engineer. From the small experiment and the satisfactory results therefrom, the Joseph Simpson Sons ordered a 125 volt, 25 r.p.m. generator and added 200 lights thereto and again exchanged the

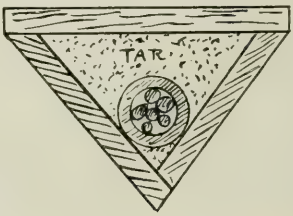


FIG. 1.

same for a 45 generator of the same type and extended their wiring throughout the entire works. The firm declare that the extra fuel required to operate this plant could not be noticed and that to all practical purposes they appeared to be securing their light at no appreciable cost whatever.

In November, 1904, the Joseph Simpson business had attained much proportions that they felt the time had come to greatly extend their already extensive works and Mr. Strickland was retained to design and supervise a complete power transmission system throughout the entire works. A large new six story mill was added to the plant and also a new modern power house, built from the designs of Mr. C. J. Gibson, the well known architect.

The power house is of brick with concrete floors and ceilings and contains three 150 h.p. return tubular boilers installed by the Goldie & McCulloch Company, together with feed pumps, fire pump and heaters, all located in the boiler house section of the power house, and a 250 k.w. C.G.E. 550 volt 200 r. p. m. three-phase alternating current generator direct connected to a tandem compound engine also installed by the Goldie & McCulloch Company. This unit, together with the switchboard and cells, is located in the dynamo room. The exciter is mounted on a rigid wall bracket placed 10 feet from the floor, which proves to be a satisfactory location, giving a neat drive from a pulley attached to the shaft of generator.

The switchboard is of blue Vermont marble, is mounted on angle iron brackets and contains oil switch, volt and ampere meter, field and exciter rheostats and six circuit switches. The main leads from generator to switchboard are conveyed in 6" tile pipe under the floor.

To each of the four mills a three-phase circuit is run from one of the switches to furnish power, and terminating on a substantial marble panel located at the point of entrance in each mill, and from this the various power circuits radiate in Richmondt conduits to each motor.

There are three transformers fed by one three-phase circuit, being one transformer on each phase, dividing the lighting into three equal sections.

The secondaries are conveyed to the main panels mentioned above in each mill and feed one side of a double throw switch and the city service the other, so that any mill may be thrown from the local supply to the city should necessity arise therefor.

The original wiring did not require to be disturbed beyond a slight rearrangement of the mains. The panels are neat and substantial, equipped with modern enclosed fuses and switches and securely supported on strap brackets and encased in neat cabinets. They were supplied, as were also the transformers, by John Forman, of Montreal.

There are some 26 motors ranging in size from 1½ h.p. to 30 h.p., all being type "K" C.G.E. three phase induction motors and all located on rigid cast iron wall brackets, which proves very satisfactory from every point of view.

There is no abnormal disturbance in the lights through the running of the motors other than what is to be expected when a motor is started.

To save cost in the running of the main feeders, from the power house to the various mills, they were drawn through iron conduits which were buried some two feet below the ground. These cables are not lead covered but are double braided rubber covered.

Considerable water entered the pipes through some unseen defect, and owing to the extremely wet ground they were raised to within 6 inches of the surface and laid in a V shaped trough of 2" pine filled with tar,

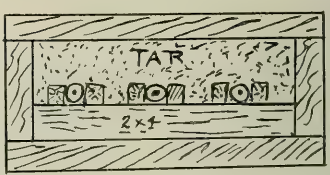


FIG. 2.

which up to the present seems to be quite satisfactory.

It appears, however, that the abandoning of the lead cable is not a good policy, and the engineer states that he believes it is not safe to trust to the conduit or any rubber insulation which may have to withstand any moisture which may arise in an underground conduit. The question of underground feeds in cases like this is one of more or less interest and even with a lead cable we are not absolutely trouble proof.

By referring to sketch Fig. 1, the method adopted in the Joseph Simpson plant will be seen, but during the progress of the works they had a visit from an English engineer, Mr. H. Moody, of Moody Bros., London, who described a system of conveying from power house to mills which has proven to be almost "trouble proof". This method is shown in Fig. 2. It consists of simply laying paper covered cables in a wooden trough on 2" x 4" cross pieces every 2 feet and separating same with wooden blocks and filling the

trough up level with bitumen and finally covering the whole with a solid 3" cover, this trough to be buried say 1 foot below the surface. The English engineer claims that for yard distribution this has given absolute satisfaction.

The Messrs. Simpson, like many others before them, in purchasing their generating unit, calculated that 250 k.w. would more than supply all their requirements, but it now appears that their rapidly increasing plant will shortly require more power, and it will likely be necessary to further extend. The new six-story mill is not yet fully equipped with the full complement of machinery that will ultimately be installed therein, and until this is accomplished and the entire plant brought down to a running basis, it will be difficult to know whether the present plant will fully provide for their ever increasing business.

The rearrangement of the drives throughout the factory was a task of no mean proportions, as it had previously been driven from a Wheelock engine and belts and was a maize of shafts, quarter turns, idlers, gears and other paraphernalia incident to belts. The drives are well worked out and in only one or two cases has resort to counters been necessary. As an illustration of what a good induction motor will stand, it might be said that one 15 h.p. motor was operating 2 rag pickers when difficulty was experienced in keeping the fuses in. This continued for some time until the load was measured and it was ascertained that the motor was operating continuously at nearly 100 per cent. overload. This motor was supplanted by a 30 h.p. motor and it is still operating another department none the worse for its severe test.

It is not an easy task to go through a large mill and fix the h.p. required for operating various sections under new conditions,and it may be said that with very slight modifications very little change was required in size of motors.

CANADIAN ELECTRICAL ASSOCIATION.

A meeting of the Executive Committee of the above Association was held at the King Edward Hotel on Wednesday, February 28th, at which several members of the Local Committee appointed to arrange for the annual convention at Niagara Falls, Ont., were also present. It was decided to hold the convention on Tuesday, Wednesday and Thursday, June 19, 20 and 21. The first day will be devoted entirely to business and the reading and discussion of papers and will include evening sessions. There will be morning sessions on the second and third days, leaving the afternoons for an inspection of the power plants and other entertainment features. The headquarters of the convention will be the Clifton House

The committee on papers have already secured the promise of several papers on suitable subjects, including one by Mr. F. O. Blackwell, of New York, reviewing the most interesting points of the different power plants Niagara Falls.

Niagara Falls is without doubt the most interesting place in Canada for a convention of electrical people, and there is every indication that the forthcoming convention will be the most successful one in the history of the Canadian Electrical Association. Mr. R. B. Hamilton, manager of the Packard Electric Company, St. Catharines, Ont., is Chairman of the Local Committee.

A NOVEL WATER TURBINE.

The utilization of power from low and variable falls of water is still somewhat uncommon in hydro-electric practice, consequently some interest attaches to a special turbine designed for a normal fall of 16 ft. at Sewall's Falls, New Haven, U.S.A. In flood times this working fall is reduced to 12 ft., making a considerable difference in the head available. A triplex form of turbine has been adopted with three sets of runners and gates complete. The three sets of runners are all connected to the tail-race by means of draft tubes, so as to derive the full energy of the water, due to its actual head, from each of the runners, no matter what its relative or actual position may be upon the shaft. The lower runner of each wheel has a draft tube by itself, while a single tube of larger dimensions carries off the discharge water from the two upper runners. The turbines are of the Francis central discharge type. The three runners on each wheel are of equal size, form and capacity ; but they do not all discharge in the same direction. The lower one discharges downwards into an individual concrete draft tube. The upper runner discharges downward and the middle one upward, both into a second concrete draft tube which joins the lower one at the bottom of the tail-race. The reactions from the upper two runners practically balance one another, while the reaction from the discharge of the lower runner, being upward, tends to lift a portion of the load on the turbine shaft. This effect is considered negligible in the turbine design, but provision is made for using the pressure due to the head of water actually to carry a considerable part of the weight of the turbines and the generators at all times. This is done by admitting the water of the flume into a space directly under the second runner of each turbine, where it exerts its pressure upward against a circular plate which forms a revolving-piston. The wheels will each produce 900 h. p. with a sixteen-foot head with a consumption of 620 cubic feet of water per second, or 625 h. p. at a twelve-foot head with a flow of 650 cubic feet per second.

NATIONAL ELECTRIC LIGHT CONVENTION.

The twenty-ninth convention of the National Electric Light Association will be held at Atlantic City, N.J., June 5, 6, 7 and 8, 1905. There has been a large addition to the membership of the Association, and a very interesting convention is expected.

MARITIME ELECTRICAL ASSOCIATION.

A meeting of the Halifax and Dartmouth members of the Maritime Electrical Association was held in Dalhousie College on Thursday evening, March 8th, the object of the meeting being the organization of a local branch of the association, as provided in the constitution. In addition, Prof. Sexton, of Dalhousie College, gave an illustrated lecture on "Power and Industrial Development at Niagara Falls."

An alarm to give warning when an injector becomes clogged and fails to operate has recently been patented, and consists of a whistle, which is sounded by the back pressure of the steam when the injector becomes inoperative.

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
38 Alliance Building, MONTREAL,

March 10th, 1906.

Mr. Jones, of the Postal Telegraph Company, New York, inventor of the "Phantoplex" System of Telegraphy, visited Montreal lately, his time being employed principally in discussing business matters with Mr. W. J. Camp, of the C.P.R. Telegraph Company.

Some firm in the United States have invented a small cooling plant for ordinary butchers' refrigerators, equivalent to 250 lbs. of ice per diem. The pumping is done by a small electric motor. If the inventor would still further reduce the output giving a capacity for 20 lbs. per diem for household use, it would be the novelty and seller of the age.

It is amusing to hear the cry of "unsightly poles" in Montreal and suburbs which occasionally is set forth by the daily press. While no one questions the advisability of the underground service, it is pretty expensive business to lay underground mains in a city with a subsoil like Montreal, and the compelling of companies to such a procedure would probably cause a higher rate of electric lighting. It is time, however, that some such project was being looked into, for the time will surely come when it must be done; in the meanwhile, several of the companies interested might lessen the cry on this question by taking down some of the numerous poles which are absolutely of no utility, but merely left standing to prevent "the other fellow" getting such location. This last remark does not pertain only to the electric light and power interests.

When the people of Montreal wake up some day and realize the fact that their whole fire alarm system is centered in a "non-fireproof" building and at the very top of same (viz., the City Hall), and which would be entirely wiped out did a fire once get properly started, they will endeavor to find the money for a suitable building. It is strange in Montreal how the money can flow for the entertainment of some delegation, but the cry is always "no funds" when a useful object like this is desired. Mr. Ferns, the able fire alarm superintendent for Montreal, has not failed to point out this weakness, but so far apparently without avail.

Mr. George Thompson, formerly assisting Mr. W. B. Kelsch as superintendent of the circuits for the Montreal Light, Heat & Power Company, has lately resigned his position with that company to take a more important one superintending the installation for the municipal electric light plant of Westmount. Mr. Thompson is a native of Belleville, Ont., and put in his first years at the electrical business on the staff of the Montreal Electric Company; later he went into business on his own account at Belleville, but not finding sufficient scope accepted a position with the late Lachine Rapids Company here, which latterly became merged into the Montreal Light, Heat & Power Company. Mr. Thompson is a thoroughly reliable man, well posted in his business, and of such character that he ought to prove the right man in the right place, and Westmount can be congratulated upon securing his services.

Our genial friend, Mr. G.H. Hill, well known to the electrical fraternity, has stepped back from the farm to once more take up the reins in the electrical business. Mr. Hill has accepted a position with the Bell Telephone Company, and although not permanently located in Montreal, is often seen around.

Mr. G. C. Rough, of the Packard Electric Company, St. Catharines, Mr. E.A. Evans, of the Quebec Railway, Light & Power Company, and Mr. H. B. Kirkland, of the American Circular Loom Company, Boston, were all in Montreal lately on a business visit.

Mr. P.H. Lahee, electrical contractor, of this city, accompanied by Mrs. Lahee, has been in Winnipeg recently. Mr. Lahee has opened a branch there and has some large work in progress.

It is possible that the late decision of the Privy Council, which hands the water power of the Cedar Rapids near Beauharnois to the Montreal Light, Heat & Power Company, may result in another transmission to Montreal, in which case there will be few cities on the continent as well attended to electrically.

The Builders' Exchange here are contemplating moving into larger premises, if such can possibly be secured at a reasonable figure in the business centre. Unfortunately, real estate owners in Montreal have become so grasping that even the ultimate benefit to them of a large Building Exchange will not tend to affect their shylock tendencies. One of the principal objects in securing larger premises is to have space for permanent exhibits of the different trades. It would certainly be a good thing for the electrical contractor to be able to take his customer and point out to him what is the latest thing in a particular line. An exhibit of electrical novelties pertaining to household use, different types of switches, fixtures and the like, would certainly attract more attention than any exhibit that plumbers, painters and other trades could make.

ELECTRICAL CONTRACTORS' ASSOCIATION.

After a long period of apathy, it was recently decided to revive the Electrical Contractors' Association of the Province of Quebec with the object of receiving due recognition for this important branch of the electrical industry. A well attended meeting was held last month in the rooms of the Builders' Exchange, Montreal, when it was decided to form an Electrical Section of the Exchange. The proceedings were marked throughout by cordiality, unanimity and a steadfast determination to further the common interests of all legitimate contractors.

The call for a meeting was met by a response from sixteen prominent firms. Mr. J.H. Lauer, the permanent Secretary of the Builders' Exchange, acted as Secretary for the meeting.

The election of officers resulted in Mr. E. W. Sayer, of the Sayer Electric Company, being chosen as president, and Mr. Wm. B. Shaw, of the Montreal Electric Company, as the representative Director to the Builders' Exchange.

The complete list of officers and members is a as follows:

President—E. W. Sayer (Sayer Electric Company).

Representative Director to the Board of the Builders' Exchange—W. B. Shaw (Montreal Electric Company).

Secretary—J. Herbert Lauer, General Secretary Builders' Exchange.

Committee—F. H. Leonard (Electric Engineering Company); R. Moncel; N. W. McLaren (Ness, McLaren & Bate); W. J. O'Leary (W. J. O'Leary & Company); S. J. Parsons (McDonald & Willson); J. E. Scott (J. E. Scott & Company); N. Simoneau.

Members—Jas. Bennett, City Electric Co., Crescent Electric Co., Electric Repair & Contracing Co., The Garth Co., International Electric Co., Jenkin-Leslie Brass Co., Philip Lahee, Metropolitan Electric Co., Henry Morgan & Co., J. R. Painchaud, Electrical Engineering Co., Fogarty Brothers, Wm. Rochon, J. J. Valois, Fred Thomson & Co., F. W. Cotten, Collyer & Brock, Canada Electric Co., W. J. Hastings, S. W. Jennings, Rend. Lionais, The Robert Mitchell Co., Limited, Peerless Gas Light Co., Limited, McDonald & Willson, Standard Construction Co., H. J. Vickerson Electric Co.

It was resolved to use the By-Laws of the Builders' Exchange as a nucleus, adding such others as might be necessary for the particular government of the Electrical Section. It is believed that this consilidated action will be an incentive to others to join and assist in furthering the trade generally in the city of Montreal.

A mistaken idea prevails with some that it is the intention of the electrical contractors in question to get together merely to fight the Union. Such is far from being the case, as in the first place it is well known that the policy of the contractors is "open shop," and a wireman is not asked whether he is "union" or "non-union." The purpose of the Association is along the lines of getting architects to submit satisfactory specifications, to endeavor to bring up the standard of construction by securing compulsory inspection at a later date, and generally to benefit the trade as a whole.

The Robb Engineering Company has received an order for a 300 horse power engine for the Alberta Railway & Irrigation Company, of Lethbridge, Alta.

The Canadian General Electric Company have been appointed sales agent for the "Blue Gloss" commutator compound manufactured by the Blue Gloss Lubricant Company, Toronto Junction. This compound eliminates the wear on the brushes and computator, prevents sparking and reduces the temperature.

MR. J. HERBERT LAUER, Secretary.

MR. W. B. SHAW,
Representative Director to Builders' Exchange.

MR. N. SIMONEAU.

MR. F. H. LEONARD.

MR. E. W. SAYER, President.

MR. J. E. SCOTT.

MR. N. W. McLAREN.

MR. W. J. O'LEARY.

MR. F. J. PARSONS.

EXECUTIVE COMMITTEE OF THE ELECTRICAL SECTION OF THE MONTREAL BUILDERS' EXCHANGE.

CANADIAN

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AND ENGINEERING JOURNAL

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Electrification of Steam Lines.

The Pennsylvania Railway has had for years a famous line running between Atlantic City and Camden, New Jersey, which latter point is immediately opposite the City of Philadelphia. This line is about sixty-four miles in length and a schedule has been maintained over it which has been of universal interest to steam railroad men, the run being made in exactly one hour. The road-bed on this section is probably one of the finest in the world, the line being practically without grades, practically straight, perfectly ballasted, and equipped with one hundred pound rails. Such a road-bed is, of course, absolutely necessary for the maintenance of such a speed with safety, for the one hour schedule mentioned includes the time of starting and stopping at the terminals, meaning that at various points along the road the speed may be as high as seventy-five or eighty miles an hour. The change from steam to electricity is an exceedingly interesting one, for the new scheme provides a three car train every fifteen minutes, running the entire distance without a stop. The schedule has been increased to eighty minutes, but doubtless the greater frequency of the service more than compensates for this reduction in speed. Each car will be a driving car, being equipped with direct current motors of two hundred horse power capacity, the three car train being controlled by one motorman through means of the Sprague-General Electric multiple unit system. Over certain sections of branch lines it has been necessary to adopt the overhead trolley, but on the main stretch between Atlantic City and Camden the third rail has been decided upon. The power house will be situated at Camden, and will contain three two thousand kilowatt, three phase, 25 cycle Curtis turbo-generators. The transmission line will be operated at a potential of thirty-three thousand, and will feed six sub-stations distributed between Atlantic City and Camden. In these sub-stations rotary converters to the capacity of eleven thousand kilowatts will be installed, delivering direct current to the third rail at a potential of 650 volts. Each individual rotary is designed for a capacity of 750 kilowatts. It is understood that the road will be in operation by the first of July this year, and the results obtained will be watched with interest by all engineers connected with this class of work. It is understood that the total expense of equipping this road will be somewhere in the neighborhood of three million dollars.

Growth of Electrical Business

Figures have been recently presented covering the sale of electrical apparatus in the United States for the year 1905, and it is with pleasure that we note that the output of machinery and supplies was about twenty per cent. greater than that of the preceding year, the figures being $210,000,000 and $175,000,000 respectively. The storage battery shows a gain of forty per cent., and this, doubtless is, due to the fact that the utility and economy of the storage battery is now practically recognized. The sale of incandescent lamps increased but ten per cent., but this is readily explained by the fact that the increase in arc lamps, Nernst lamps, and mercury vapor lamps increased by a much higher percentage. The figure for the earnings of street railway, telephone,

telegraph, and electric light and power companies for the year 1905 is $720,000,000 as against $620,000,000 for the previous year, showing an increase of about sixteen per cent. When one considers that in the United States alone, for the year 1905, $210,000,000 was spent for apparatus and $720,000,000 was earned, he feels almost convinced that the electrical business is at last on a substantial footing. It is very difficult, as you will readily understand, to collect reliable data upon matters of this kind, and the United States Census Office is certainly to be congratulated for the very effective work which has been accomplished. The information concerning electrical manufacturing is collected at five year periods, but figures relating to lighting, railway, and similar industries are collected but once in ten years. We understand that the Census Office is advocating a reduction of this period to a term of five years, and while this about doubles the amount of work for the department, it has been found that the enormous growth which has taken place in this branch of electrical business makes it worth while to collect the information at more frequent intervals. We cannot hope to see reliable information placed before the engineers of Canada for some time to come, but if in the United States the year 1905 showed an increase of twenty per cent. over the previous year, we think we can say with all conservativeness that the increase in the Dominion of Canada was at least fifty per cent. So far as electrical work is concerned, Canada is now going through the same development which was experienced in the United States some ten years ago, and with the abundance of water power which we have in this country, it is quite within reason to believe that the period of advancement will continue for a greater number of years than it did in the United States. Not very long ago there was one large manufacturing company in Canada, and one of smaller size. The larger company eventually absorbed the smaller, and had the field pretty much to itself, though it was not long before serious competition was experienced from the manufacturers on the other side of the line. These American companies gave serious consideration to Canada as a market for their products, and evidently the proposition appeared in such a favorable light that Canadian factories have been built, and are now in operation. If a coal famine should ever be experienced, then the country which has water power is going to go ahead with enormous strides, and probably there is no country in the world which ranks upon an equal basis with Canada in this respect.

High Potentials.

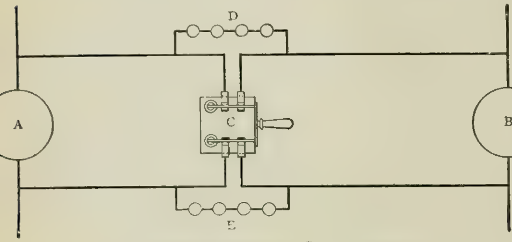
The average central station attendant, who is found in the smaller plants, and who has been accustomed to operating voltages which, comparatively speaking, are low, has little or no conception of the care which has to be exercised in the handling of the higher pressures. A man who has been accustomed to direct current work at say 500 volts, or alternating current work at one thousand volts, seems to be under the impression that with the addition of a greater insulation the use of eleven thousand or twenty-two thousand volts becomes a simple matter. But when these men get in actual touch with such potentials, their opinions undergo a marked and rapid change, and they become imbued with a sincere respect for everything over two thousand. In Canada the average potentials are rapidly increasing, and where two thousand volts was considered an extra high potential but a few years ago, we now have plants operating at twenty-two thousand, and at other points voltages of fifty and sixty thousand have come into use. We see evidences all over the country of careless engineering work, that is to say, careless when considered in connection with high pressures. A line might be constructed for two thousand volts or even four thousand volts which is entirely satisfactory, but when this same line is, with a change of insulators, subjected to eleven thousand, conditions change materially. We had occasion recently to observe the action of as low a potential as two thousand under conditions where the humidity was excessive, and we felt rather thankful that the voltage was not twenty-two thousand. What might have occurred under this latter pressure is impossible to say, but even under the lower pressure mentioned the leakage was sufficient to form short circuits. The lines and insulators were subjected for a number of hours to an immense quantity of steam inside a power house, and it did not take very long before the leakage became evident to the eye, and shortly after this the short circuit occurred, luckily doing nothing more than opening the circuit breakers. We desire to point out that too much care cannot be taken in the putting in of wires intended for high potential work, whether these wires be inside a power house or outside on a line. We remember one instance where a line voltage of four thousand was used and a special glass insulator was employed for carrying the wires. These insulators were of the umbrella type, the upper petticoat being about five inches in diameter, and gave absolutely no trouble under all atmospheric conditions. A building was burnt close to the transmission line at one point, and the adjacent pole and cross arms were destroyed. A new pole was erected and a new cross arm put in place, but the construction man, having had no difficulty with the insulators originally installed, came to the conclusion thet a smaller type would be equally satisfactory, and following his judgment he made use of anything which came handy. If he had adopted the standard deep groove, double petticoat insulator, things might or might not have been alright, but instead of this he went to extremes and put up on this pole three telephone insulators known as the pony type. While the weather was dry there was no trouble, but with the coming of the first heavy rain storm the plant shut down and the construction man went out and replaced the little insulators with ones of proper construction. That man has had one point brought very forcibly to his attention, namely, that the engineer who designed that equipment knew what he was doing when the heavy insulators were called for, and in all probability should any of the insulators need replacing in the future, the pony telephone type will not receive much consideration.

The town of Port Hope will apply to Legislature for authority to issue debentures not exceeding $10,000 for the establishing of an electric light plant.

The Lyons Electric Company, of Brantford, Ont., want a ten years' franchise for commercial lighting. If they obtain the rights they may generate electricity by a gas-engine unit. They intimate that they may start a factory for the manufacture of electrical supplies.

SYNCHRONIZING ROTARY CONVERTERS*

When a rotary converter is started from the direct current side or by a separate starting motor, it must be in synchronism with the alternating current bus bars before it can be connected to them. Two machines, a generator and a rotary converter, for example, are said to be in synchronism when their frequencies are the same and when their phase is the same. The two machines will have the same frequency when the numbers of alternations or reversals of their e.m.f's. in a given time are equal. This condition will be fulfilled when the product of the number of poles by the revolutions per minute for each machine is the same. The two machines will have the same phase when the positions of the armatures with respect to the field poles are the same, i.e., when similar armature coils are opposite positive field poles at the same instants. In addition to being in synchronism with the generator to which it is to be connected, the rotary converter must have approximately the same voltage as the generator as measured by a voltmeter.



LAMP METHOD OF SYNCHRONIZING.

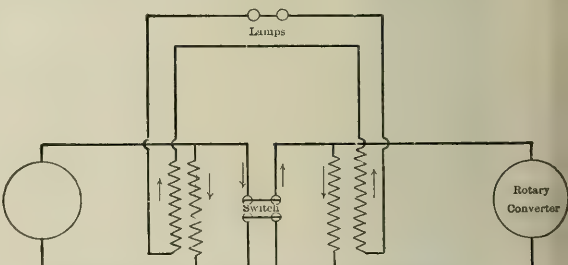
The operation of synchronizing a rotary converter with a generator consists in bringing the rotary converter up to approximately synchronous speed and to the same voltage as the generator, and then when the inevitable fluctuation in the speed of the two machines brings them in phase, in connecting them together. When the two machines have the same frequency, the same phase, and the same voltage, there will be no unbalanced e.m.f. and consequently no rush of current when the machines are connected together.

In synchronizing two machines it is evidently necessary to have some means for determining when the frequency and phase position of the incoming machine are right. The principle of the most common method of doing this is shown in the above diagram.

A and B represent two single phase machines or a single phase each of two machines, the leads of which are connected to the switch C, through two series of incandescent lamps, D and E. It is evident that as the relative positions of the phases of the electromotive forces change from that of exact coincidence to that of exact opposition the flow of current through the lamps varies from a minimum to a maximum. If the electromotive forces of the machines are in phase and of the same value, the current through the lamps will be zero. But as the difference in phase increases, the lamps will light up and increase in brilliancy until the maximum is reached, when the phases are in exact opposition. From this position they will decrease in brilliancy until dark, indicating that the machines are in phase again. The rate of pulsation of the lamps depends on the relative frequency of the machines to be synchronized. If this rate is reduced to about one pulsation in ten seconds, ample time is allowed for closing the circuit.

The synchronizing device instead of being connected directly across the two circuits may be connected in the secondary circuit of two shunt transformers as shown in the following diagram. There are two transformers, the primaries of which are connected across the generator circuit and rotary converter circuit, respectively, and the secondaries of which are connected in series through the lamps or other synchronizing device. If the transformers are connected similarly in the two circuits there will be no current through the lamps when the machines are in phase since the electromotive forces of the two transformers will be opposed, as shown by the arrows in the diagram. When the machines are out of phase the electromotive forces will be out of phase also and current will flow through the lamps, the amount of the current and the resulting brilliancy of the lamps depending on the difference in phase. If the connections of either the primary or secondary of either transformer be now reversed from those shown in the diagram, the indications of the lamps will be reversed; that is, when the machines are in phase the lamps will burn at maximum brilliancy. In common practice the transformer connections are so made that the lamps shall be dark when the machines are in phase.

In order to determine whether the synchronizing lamps will be bright or dark for a given connection of transformers when the machines are in phase, raise the alternating current brushes off the collector of the rotary converter and close the alternating current switches. Since the primaries of both transformers are now connected to the alternating current line the synchronizing circuit will be operating under the same conditions as when the main switches are open and the rotary converter is in phase with the line. If the lamps burn brightly, and it is desired that they be dark for an indication of synchronism, the connections of one of the primaries or one of the secondaries of the transformers would be reversed. The lamps should be adapted for the highest voltage which they will receive. If they are placed upon the secondaries of two 100-volt converters, there should be two 100-volt lamps or four 50 volt lamps in series.



TRANSFORMER AND LAMP METHOD OF SYNCHRONIZING.

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Lamps are commonly used as the synchronizing device, but they are objectionable for the reasons that it requires a large difference of phase to make them glow and that they do not distinguish between a machine running too fast and one running too slow.

The ideal synchronizer should perform three distinct functions.

(1) It should indicate whether the incoming converter is running too slow or too fast.

(2) It should indicate the amount by which an incoming converter is too slow or too fast.

(3) It should indicate the exact time of synchronism or coincidence in phase between the bus bars and the incoming converter.

to that of the line the pointer stops at some position on the scale, and when the rotary converter is in phase with the line the pointer coincides with the dummy pointer at the top of the scale. The main switch may then be closed.

Two shunt transformers are necessary to connect the instrument to the bus bars and one additional shunt transformer to connect it to each machine to be synchronized. When installed the same shunt transformer may be employed in connecting other instruments to the bus bars and machines.

THE AUTOMATIC SYNCHRONIZER.—The uncertainty in synchronizing which arises from the hand-throwing of

WESTINGHOUSE SYNCHROSCOPE.

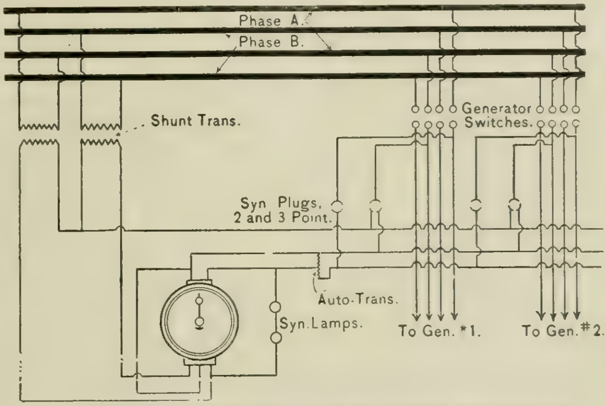
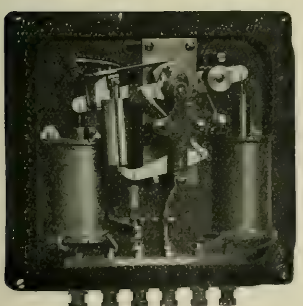


DIAGRAM OF CONNECTIONS FOR WESTINGHOUSE SYNCHROSCOPE TWO-PHASE CIRCUITS OF 500 VOLTS AND LESS.


VIEW OF AUTOMATIC SYNCHRONIZER.

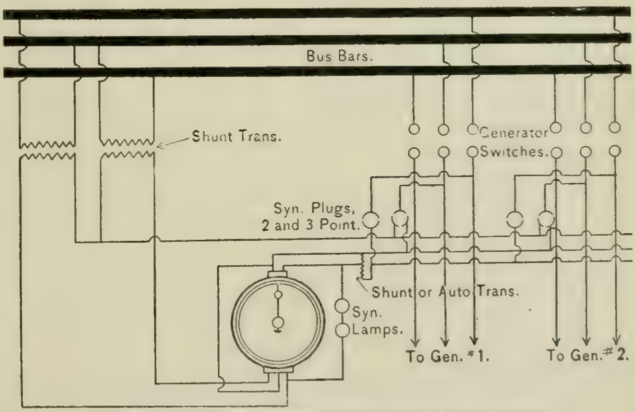


DIAGRAM OF CONNECTIONS FOR WESTINGHOUSE SYNCHROSCOPE THREE-PHASE CIRCUITS OF 500 VOLTS AND LESS.

These functions are performed with perfection by the Westinghouse Synchroscope which is herewith illustrated. The instrument is provided with an indicating pointer. The phase angle between the converter and the generator is always equal to the angle between the pointer and its vertical position marked on the dial of the instrument. If the frequency of the incoming machine is higher than that of the line, this angle will vary, causing the pointer to rotate in one direction. If the incoming machine is lower in frequency the pointer will rotate in the opposite direction. Fast and slow on the dial mean that the frequency of the rotary is higher or lower than the frequency of the line. When the frequency of the converter is equal

switches is done away with by the automatic synchronizer.

The instrument consists essentially of two solenoids, the upper ends of whose moveable cores are flexibly connected to either end of a cross-beam pivoted at its center as an ordinary walking-beam. These solenoids are so connected that the one receives a maximum current at the instant of synchronism and the other receives a minimum current at the same instant. To accomplish this, the right-hand solenoid is connected in the same manner as a synchronizing lamp is connected to synchronize light and the left hand solenoid is connected like a lamp to synchronize dark.

Attached to the shaft of the cross-arm is a small

contact finger or clip. This contact device is for closing a circuit through the relay switch which closes the circuit through the closing coil of an electrically operated switch at the proper moment of synchronism. The current for actuating the switch is taken from a source independent of the generators, such as the exciter. To the cross-beam is also attached one element of a dash-pot. The other element is connected through a system of levers to a disc of insulating material mounted on a short shaft in line with the pivot of the cross-beam. A small metal segment mounted on the disc is a little longer than the gap between the movable clip and a stationary clip, when the clips are at their minimum distance apart. Mechanical adjustment is made such that this minimum distance point is reached coincident with the point of synchronism. Reference to the illustration will show how this dash pot action on the disc prevents the movable clip from making contact with the stationary clip when the rocking motion of the cross-beam is too rapid. Before the incoming machine has approached synchronism both of the solenoids are acted upon equally by currents from the synchronizing transformers and the cross-beam will assume a position midway between its two extreme positions. As the point of synchronism nears, the beam will begin to oscillate, following in its movements the variations in the currents. In one solenoid the current is a maximum while in the other it is a minimum, and vice versa. As soon as the oscillation becomes slow enough, the dash-pot is pulled out to its maximum length with the forward movement of the beam, and the contact piece on the insulating disc remains in the proper position to make the circuit between the moving and the stationary clips.

If the voltage of the incoming machine differs considerably from that of the bus bars to which it is to be connected, the device will not close the contact since the effect of the excessive voltage on the left-hand solenoid is to hold that end of the beam too low at the moment of synchronism. It is thus seen that the incoming machine will not be thrown in unless the voltages are approximately equal, the machine is in phase with the line and the frequency is right.

A controller and relay switch are interposed in the circuit with the synchronizer and the electrically operated switch. By means of the controller switch the main or electrically operated switch may be tripped, but cannot be closed, as the closing coil is normally out of circuit until the synchronizer is in the position assumed at the synchronous operation of the generators or rotary converters, that is, when the solenoid of the relay is energized and the contacts closed. This closes the relay switch circuit and completes the path of the current through the controller and electrically operated switches.

The relay switch is provided with carbon break and relieves the contacts of the synchronizer from excessive currents.

Synchronizing Polyphase Converters.—What has been said in regard to the synchronizing of two single-phase circuits applies equally well to the synchronizing of the individual and similar circuits of polyphase rotary converters.

In the paralleling of polyphase machines the location of the different circuits in the armatures and the connections of those circuits to the switches require special consideration.

Two-Phase Converters.—The four collector rings of two-phase rotary converters are marked A1, B1, A2, B2, consecutively, beginning with the collector ring nearest the armature. These collector rings are connected to the winding 90 electrical degrees apart, so that A1—A2, and B1—B2, which are 180 electrical degrees apart, are the terminals of the main circuits of the converter winding, across which the normal voltage may be impressed. The circuits between adjacent collector rings are called the side circuits of the converter.

In connecting the rotary converter and line to the alternating current switches it is first necessary to locate the main circuits of each. In the case of the converter this must be done by tracing the cables back from the switches to the collector rings. The main circuits of the line may be located with a voltmeter. If the generator armature winding is of the closed coil series type, the voltage across the side circuits will be about 70 per cent. that of the main circuits, or if the generator armature winding is of the open type there will be no connection between the two phases and consequently no voltage except across the main circuits.

When the corresponding circuits of the line and rotary converter have been located the main circuits of the converter should be so connected to the switches that the main circuits of the converter will be connected to the main circuits of the line when the switches are closed. There is still a chance that the two phases of the rotary converter may be dissimilarly connected to the line so that the electromotive force of one phase will be in phase with the line while the electromotive force of the other phase will be opposed to that of the line. In order to determine whether or not these connections are correct, two synchronizing devices, one for each phase, must be connected in circuit simultaneously. The connections for each phase are identical with the connections for one phase (shown in the diagram herewith). If transformers are used with the synchronizing lamps, each set of lamps should be tested out separately as previously described to insure that the lamps will all be dark when indicating synchronism. If the two phases are relatively correct the two sets of lamps will be bright at the same time and dark at the same time when the converter is being synchronized. If such is not the case it will be necessary to reverse the connections of one of the phases of the converter. If transformers are used with the lamps it may now be necessary to change some connections in the synchronizing circuit in this phase, depending upon the place in the main circuit in which the leads were reversed. The synchronizing lamps should therefore be retested to make sure that both sets of lamps are dark when indicating synchronism. It will now be found that when the rotary converter is synchronized and one phase connected to the line, that the lamps in the synchronizer of the other phase will be dark, indicating that that phase is also in synchronism. Therefore the converter may be synchronizrd by a synchronizing device in only one phase after the correctness of the connections has been determined.

Three-Phase Converters.—In three phase circuits there is no way of locating the different phases of the line except by tracing the leads back to the generator. The collector rings of all three-phase machines are marked A, B, C, starting from the collector ring nearest the armature winding. It is usually most convenient to connect the three leads from the converter to the switches without reference to their order and to test the correctness of the connections by means of the synchronizing device.

If synchronizing lamps are connected directly across the main switches (as shown in diagram) it will be necessary to connect in three sets of lamps in order to determine the correctness of the connections unless the separate switches can be closed independently. In this case lamps may be connected across two of the switches and the third switch closed. If transformers are used in connection with the synchronizing lamps, only two sets of lamps will be required as each transformer is connected between two legs of the three-phase circuit. In this case each set of synchronizing lamps must be tested out as previously described to insure that all lamps will be dark when indicating synchronism.

When the converter is correctly connected to the line, all lamps will be bright at the same time and dark at the same time. If it is not correctly connected pairs of leads must be interchanged until the lamps "blink" together. When it is known that the converter connections are correct one set of synchronizing lamps will suffice for synchronizing the converter.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstaces warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the moth preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. No. 1.—Is it possible to operate twenty 32 candlepower incandescent lamps in series or in two groups of ten light each, on a 500 light, single phase, 60 cycle alternater? What current would be required, and what size of wire is most suitable? Is the use of a chocke coil in shunt with each lamp absolutely necessary? If so, can you give me an idea of the size and amount of wire used in constructing one? If the safety cutout in the socket of each lamp is as suitable as a choke coil in shunt, would you kindly quote prices and name of manufacturers. Voltage at power house is one thousand.

[NOTE:—The above question came to us under date of January 29th last but was not answered in our February issue owing to lack of space. We have received from the same town an almost similar question dated February 26th, and while the name signed to the first letter is not that given in the second, we are inclined to think that the enquiries came from the same party. The only difference is that in the letter of February 26th the question relates to the operation of eighteen 32 candle power 110 volt lamps in two series groups of 9 each. Therefore we are taking the two questions together and answering them as one. If the following answer does not cover both questions fully, and our correspondent will advise us of the fact, we will be pleased to give further information.—The Editor.]

ANS.—The twenty 32 candlepower lamps could be operated in series on the thousand volt line, provided lamps of a voltage of approximately 50 were used, but if it be desired to divide the lamps into two groups of 9 or 10 lamps each, then 100 volt lamps could be used. The current in each branch, should 32 candlepower lamps be used, would be approximately one ampere, and information is given in the first letter that each branch is to be at least one half mile in length. The thing which governs the size of wire in this question is mechanical strength rather than resistance, and if there is any fear from sleet we would say that nothing smaller than a No. 6 wire is advisable. If there is no fear from sleet, it is possible that a No. 8 wire could be used with satisfactory results. The resistance of one half mile of No. 8 wire is only about 1.65 ohms, and with a current of one ampere flowing, the total drop due to the resistance of the line would not exceed 1.65 volts. Therefore this point need not be considered further. In fact, No. 10 or No. 12 wire, if of sufficient mechanical strength, could be used so far as resistance is concerned. In installing a series incandescent system, such as is suggested, some means must be used to keep the current in the line constant, for should the current get low the lamps will burn dimly, and should the current get high they will burn with intense brilliancy and probably some of the filaments will break. Where a choke coil is used in shunt with each lamp, no other regulating apparatus is required, for the action of the shunt choke coil is very simple. When a lamp is burning practically no more current goes through the shunt coil than is required to magnetize the iron, and this is very small compared to the current taken by the lamp. Should, however, the filament of a lamp break, then the only path of the current is through the choke coil, and this is so designed that the wire will have capacity to carry the full current without undue heating, and generate a voltage equal to that of the lamp, and opposing the voltage impressed on the system. This practically means that the burning out of a lamp will not change the effective resistance of the circuit, and should a lamp burn out the current in the other lamps will remain practically unchanged. If no regulating devices are placed in the line, then the use of a choke coil is imperative, for should a filament break, the circuit will be open at this point and full line voltage, namely, one thousand, would be placed across the broken lamp. We have no information at the present time concerning the number of turns and size of wire used in the construction of these choke coils, nor are we able to quote prices on same. For this information we would refer our subscriber to any one of the large manufacturing companies, who doubtless will be quite willing to give the desired information. Regarding the construction of these shunt coils by local people, we would point out that the device is doubtless protected by patents and should an attempt be made to manufacture them a law suit would probably result. The only time where safety cutouts are used is when there is some regulating device in the power house, which will control the current in the system. Of course, the only automatic device which can be used for this work is built on very similar principles to the constant current transformers used for series arc lighting. An adjustable choke coil, hand operated, is very often used for regulating the current in a series incandescent system, but this, of course, is not automatic in any sense of the word. When a filament breaks in a lamp, the safety cutout simply short circuits that lamp, and prevents a break occurring in the system, but when this action takes place the resistance of the system is immediately reduced by the amount of the resistance of the lamp which is cut out, and hence the current will immediately increase unless some change is made in the regulating device at the power house. The adjustable choke coil mentioned is a somewhat expensive device, comparatively speaking, and it is our opinion that a satisfactory substitute can be rigged up at a very low cost. If in each series of lamps a number of short circuited lamps are placed in the power house, arranged with switches so that they can be cut into the line, then the resistance of the circuit can be increased to the normal point should a lamp on the outside become broken.

The Pembroke Electric Light Company have given the contract for the installation of their plant at Black River to the Canadian Westinghouse Company.

Hon. Robert Mackay, John E. Aldred, Howard Murray and J. C. Smith, of Montreal, and Thomas McDougall, of Quebec, have been incorporated as the Southern Electric Company, with a capital of $500,000. This company will, by an arrangement with the Shawinigan Water & Power Company, control the distribution of Shawinigan Falls power in the counties of Nicolet, Yamaska, Bagot, Megantic, Wolfe, Beauce, Richmond and Sherbrooke.

Structural Design of Towers for Electric Power-Transmission Lines*

By Joseph Mayer, M. Am. Soc. C. E.

The most extensive experience with structures approximately answering the purpose of electric transmission line towers has been with timber telegraph poles. There are several important differences between telegraph or telephone and power transmission lines. On the former are small wires, frequently numerous, which carry harmless currents. The overturning of one line by an exceptionally severe storm accompanied by sleet on the wires, causes comparatively little inconvenience. This combination is rare and local, and the wind pressures along the narrow track of the storm center are several times as large as those commonly occurring. The percentage of lines of the now usual strength yearly destroyed is small. To build all the lines strong enough to resist the most exceptional wind pressures would cost much more than to follow the present practice and to replace the few lines destroyed. On power transmission lines the overturning of a line is a more serious matter, causing great inconvenience, and the dangerous currents may cause loss of life. Such lines should therefore be built strong enough to resist not only the commonly occurring, but also the exceptionally violent local storms. The degree of safety aimed at in buildings and bridges, and the wind pressures assumed in their design, are therefore better guides in the design of such lines than the precedents furnished by telegraph pole lines.

Wind Pressure.—Bridges were first generally designed without scientific determination of the wind strains. Terrible disasters were an occasional consequence. One of these, the fall of the Tay bridge in Scotland, with a crowded passenger train, drowning all on board, led to the English standard for wind pressures, which is 56 pounds per square foot of plane exposed surfaces and one-half as much for cylindrical surfaces (counting diameter into length as the exposed area). In this country 50 pounds per square foot of exposed surface is a frequent standard. The most eminent engineers are, however, now of the opinion that such pressures occur only over small surfaces, and that 30 pounds per square foot of exposed surface is a liberal allowance for areas extending over considerable distances. The larger pressures assumed in the design of short-span bridges are chosen mainly for resisting the tendency toward lateral vibration under apidly moving trains. The great difference between the pressure on large and small areas arises from the fact that the wind pressure acts in gusts or is oscillating, and the oscillations are not synchronous over any considerable extent of space. The wind pressure over a large area, or one extending at least in one direction over a considerable distance, approaches the average of the pressure during the oscillations, while a small pressure gauge gives the maximum. The New York Building Code and many other building laws prescribe for high buildings 30 pounds per square foot of exposed surface.

The observed wind pressures greatly decrease as one approaches the surface of the ground. This is an additional reason why an assumed wind pressure of more than 30 lbs. per sq. ft. is unreasonable for a transmission line the towers of which are rarely more than 60 ft. high. Pressures on cylindrical surfaces are by experiment shown to be only 0.5 to 0.6 those on plane surfaces. A pressure of 18 lbs. per square foot of exposed surface of wires, counting the product of diameter into length as the area, is, therefore, a liberal assumption.

Ice Load.—Another force endangering the safety of a line is the weight of the ice gathering on the wires. This force is generally more important for telegraph than for power-transmission lines. Telegraph wires of ⅛-in. diameter have a cross-section area of 0.0075 sq. ins. Strands of 350,000 c.m. used for the transmission of large amounts of power are of 0.67-in. dia. and have a cross-section of 0.275 square inches. A coat of ice ½-in. thick increases the diameter and the area exposed to wind in the former case nine times, in the latter less than three times. The weight carried by copper wires is increased nine times in the former and 1.7 times in the latter case. The power transmission lines carry, at least during part of the day, a large current producing considerable heat, which hinders the accumulation of a large amount of ice.

A very important fact in judging the amount of wind pressure on the wires is also the absence of tornadoes during very cold weather. In a recent article in the Geographical Magazine for June, 1905, by Prof. Willis L. Moore, Chief of the Weather Bureau, the conditions for the occurrence of a tornado are given; one of them is a temperature of about 70° F. at 8 o'clock in the morning. Tornadoes are the only storms which produce near the surface of ground wind pressures at all approximating those assumed. While it may, therefore, be reasonable to assume in our climate a coat of ice ½ in. thick, increasing the diameter 1 in., it is not reasonable to assume this coat at the same time with the maximum wind pressure. The wind pressure on the tower itself is also much smaller in severest winter weather than during the tornadoes of spring and summer. The latter seasons are therefore probably the most dangerous for the towers of power transmission lines with three or six large strands, while for the numerous small wires of telegraph lines and their poles the ice-covered wires exposed to winter storms are most likely to cause their destruction.

In the design of a line the first thing is to select the least clearance between the wires and the surface of the ground. This is determined by considerations of safety, and is partly dependent on the voltage of the current. The distance between the three wires of a circuit also depends on the voltage and on the altitude of the region above sea level. The rarified air of high altitudes is a poorer insulator than the denser air near sea level. The wires must be farther apart in the former than in the latter case, to secure the same amount of leakage between the wires; 60,000 volts is now about the upper limit of voltage and 7 ft. distance between the wires has been chosen for lines near Niagara Falls for this voltage.

The best distance between towers can only be determined by making designs for different spans and

*Reprinted from the Engineering News.

comparing their cost. The great cost of high tension insulators and the high cost of timber, together with its perishable nature, have made short span timber pole lines uneconomical for high tension power transmissions. Steel towers have so far taken their place, and they will be probably followed by towers of reinforced concrete. Spans between 300 and 800 feet are economical for different designs and sizes of wire.

After the span is assumed the maximum deflection of the wires must be determined. To calculate the latter with a given size and strength of wire or strand, the amount of ice, the wind pressure with and without ice, and the maximum tension in the wire must be chosen.

Assumed Data.—A coat of ice 1 in. thick, making the diameter 2 ins. plus diameter of wire, has been assumed by some engineers, with a unit strain of 40,000 pounds per sq.-in. on hard drawn copper wires. The amount of ice and the unit strain are about equally excessive, and the result obtained with some sizes of wire is not unreasonable. A 1½-in. coat of ice will by most engineers be considered a sufficient allowance in all places except near waterfalls. It is claimed by some that the heat produced by the current will prevent the formation of ice. The elastic limit of strands made of small wires about No. 10 B. & S. gauge is at least 35,000 pounds per sq. in. A unit strain equal to two-thirds the elastic limit will give about the degree of safety adopted for bridges and buildings. The proper wind pressure for the bare wire was given at 18 pounds per square foot; that for the ice covered wire will be differently estimated from the few known data. With the moderate unit strain here assumed it will be safe to take the total wind pressure on the ice-covered wire the same as on the bare wire for a strand of 350,000 c.m. and 0.67-in. dia. The weight of such a strand is 1.05, and with 1½-in. thick ice 1.8 pounds, per foot. The assumed wind pressure acting normal to the weight is 1 pound per foot. A considerable difference in the assumed wind pressure will not much affect the resultant maximum deflection with a given strain or the maximum strain corresponding to a given maximum deflection. For calculating the latter the greatest variation in the temperature of the wire is required. This is about 150° F. in the eastern and central United States, but is generally much less in tropical and subtropical countries. The modulus of elasticity of hard-drawn copper strands may be taken as 16,000,000 pounds per sq. in. The coefficient of expansion per degree Fahrenheit is $1 \div 104{,}400$. A sufficiently approximate formula for the length of the wire between two insulators is

$$S = L + \frac{8\,D^2}{3\,L},$$ where S is the length, L the span, and D the deflection.

Calculation of Deflection and Stress.—I shall take as an example a 660-ft. span and a strand of 350,000 c.m., or 0.275 sq. ins. With the above given weight and wind pressure the force acting on the strand is $\sqrt{1.8^2 + 1^2} = 2.06$ pounds per lin. ft. The permissable strain in the strand if taken at two-thirds the elastic limit, is 6,417 pounds. Its deflection at minimum temperature with the assumed wind pressure and ice ½-in. thick, is given by the formula

$$D = \frac{660^2 \times 2.06}{6{,}417 \times 8} = 17.48 \text{ ft.}$$

The deflection of this strand at maximum temperature under the influence of its own weight must be found to determine the height of the wire at insulators. The shortest way, after some experience, is to guess at the deflection, calculate the strain in the wire, its length corresponding to the strain and temperature, and also the length corresponding to the deflection. The two lengths should agree; if they do not, another guess must be made and the calculation repeated. The length of wire with 17.48 ft. deflection is

$$S = 660 + \frac{8}{3}\,\frac{17.48^2}{660} = 661.234 \text{ ft.}$$

This deflection obtains with a strain of 6,417 pounds in the wire at minimum temperature. If we now guess the maximum deflection to be 20 ft. the strain is

$$t = \frac{660^2 \times 1.05}{8 \times 20} = 2{,}858 \text{ lbs.}$$

The reduction in strain $6{,}417 - 2{,}858 = 3{,}559$ pounds. The shortening of the wire due to this reduction is $(3{,}559 \times 661.2) \div (0.275 \times 16{,}000{,}000) = 0.535$ ft. The

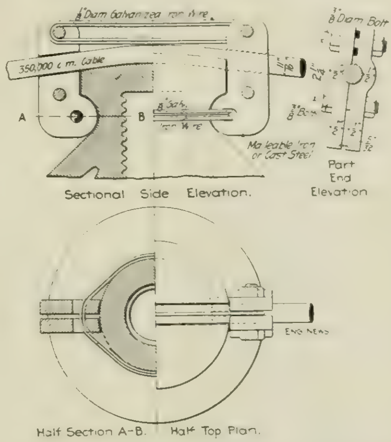


Fig. 1.—Proposed Design of Sleeve or Friction Clamp for Fastening Power Transmission Line Wires to Insulators.

lengthening of the wire due to change of temperature is $(661.234 \times 150) \div 104{,}400 = 0.950$ ft. The length of the wire at maximum deflection calculated from strain and temperature is $661.234 + 0.950 - 0.535 = 661.649$ ft. The length of the wire calculated from the deflection is $S = 660 + \frac{8}{3}\,\frac{400}{660} = 661.616$ ft.

The length calculated from deflection is 0.033 ft. too short. The actual deflection is therefore a trifle larger than guessed at.

Mr. F. O. Blackwell has found for hard-drawn copper cable a modulus of elasticity of 12,000,000 pounds instead of the 16,000,000 pounds here assumed. This modulus depends on the length of twist, and varies with different cables. If 12,000,000 pounds is taken, the maximum deflection becomes 19 ft. 2 ins. for our example.

The maximum deflection and the clearance give together the height of the lower insulators.

Longitudinal Forces.—The forces acting on the towers in a direction normal to the line have been discussed in the foregoing. They are, at least with large strands, probably greatest during tornadoes when there is no ice on the wires. The forces in the direction of the line depend on the design

adopted. As long as all the wires are intact, practically the only force acting in the direction of the line is the wind pressure on the towers. If a wire breaks there is a one-sided pull at the two nearest insulators. With a No. 8 B. & S. gauge wire this pull is at most a few hundred pounds, and the insulator, its pin, the cross-arm and the tower can easily be made strong enough to resist it without sliding of the wire as insulators. With a strand of 350,000 c. m. of hard drawn copper, the tension at minimum temperature with ½-in. ice is, in accordance with the deflection here recommended, 6,417 pounds. This would require, with wires firmly attached to the insulators, very strong and expensive insulators, pins, cross-arms and towers. To avoid the consequent excessive cost, the exposed to a one-sided pull at both ends of cross-arm keep the cost of the towers within financially practicable limits, the wires are loosely attached to the insulators, so that they can slide; in this case, the forces arising from the breaking of a wire are distributed over several insulators, cross-arms and towers.

To keep the distance along which this sliding of the wire at insulators takes place within moderate limits two methods are available. The wires may be so attached to the insulators that there is considerable friction, and the towers designed to resist the forces arising therefrom; or stronger towers may be placed at intervals with double insulators and extra strong insulator pins and cross-arms, with the wires firmly attached to the insulators. In this latter case the

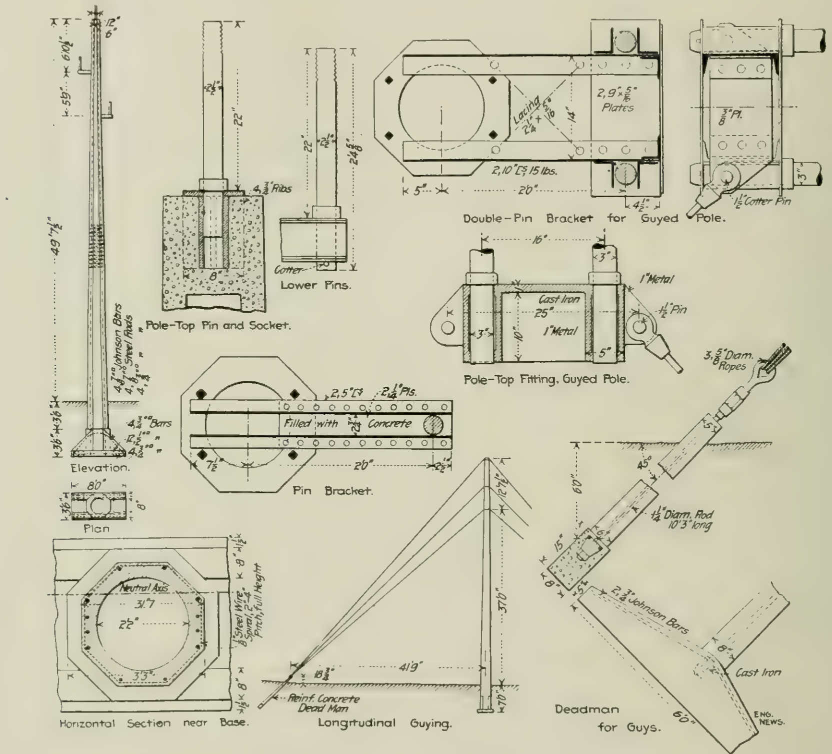


FIG. 2. -REINFORCED CONCRETE POLE WITH SPREAD BASE, FOR SINGLE THREE-PHASE POWER TRANSMISSION LINE.

strands must in this case be so connected to the insulators that they can slide without too much friction. If this friction is made very small the breaking of a strand will make it slide along a large number of insulators on each side of the break, and it will come down to the ground in several spans.

There may be distinguished three different methods of meeting this problem. The wires may be firmly attached to all insulators so as to prevent their sliding. This is practicable with small wires, especially where they are numerous. Where there are only three large wires or strands, two of them on a long cross-arm, and all supported on pyramidal towers, the breaking of one wire at one end of cross-arm will twist the adjacent towers. This twisting will so change the length of the adjacent spans of the wire at other end of cross-arm as to produce a torsion partly counterbalancing the first. The towers nearest the break are and to a torsion. To make these forces moderate and ordinary towers can be safely built without much torsional strength. The wires should then be so attached to the insulators of ordinary towers as to permit easy sliding, or the cross-arm should be so connected to the tower that it can swivel around it, or the tower should be flexible to permit its twisting without over strain, or all three may be to some extent combined.

This solution of the problem has been adopted on some lines under construction near Niagara Falls. The extra strong towers at intervals are provided with guys attached at both ends of the cross-arms and going in both directions of the line, which relieve the towers of torsional strains and of forces acting in the direction of the line. These towers consist of three 2½-in. gas pipes forming a triangular pyramid; they are braced by horizontal struts and diagonal rods. The

connections are by means of malleable iron castings.

If all the towers are made of the same strength the greater torsional forces may be provided for by building towers consisting of two triangular bents having their planes parallel to the transmission line as far apart as the two side wires, the third wire being in the center between them, the two bents braced together by struts and diagonals. Such towers can be economically designed to resist much larger forces acting in the direction of the line than can well be provided for in pyramidal towers. Towers for two lines of three strands each are frequently built in this manner with the distance between the bents equal to that from center to center of line.

The attempt to provide for a line consisting of three large strands, towers of great torsional strength, and able to resist large forces in the direction of the line which arise from the breaking of one or more firmly attached strands, greatly increases the cost of the towers as soon as these forces are assumed to be larger than those acting normal to the line. The only drawback of towers of equal strength normal to and along the line, with strands that can slide along the insulators with sufficient ease to make the towers safe when one or more strands break, is the sliding of the strands over a considerable distance from each side of the break. With large strands with the factor of safety here assumed, and with careful inspection and testing of the strands for strength, the breaking of a strand will be an extremely rare occurrence. It is therefore not economical to build towers that are safe with firmly attached strands for the purpose of avoiding the inconvenience arising from this sliding of the strand in case of a break. By using sleeves or clamps made in halves surrounding the strands at the insulators they can be firmly attached to the latter without producing large friction against sliding. A design by the author for such a friction fastening is represented in Fig. 1 herewith. Friction opposing the sliding of a strand is larger at the start than after the motion has begun.

With the towers here chosen for an example, for three strands of 350,000 c.m. and 660-ft. spans, a pull of 1,000 pounds at any one of the strands or one of 2,000 pounds at the three strands can be easily provided for without much additional cost, by towers having equal strength in direction normal to and along the line. The solution of the problem of the forces along the strands here proposed is to design the towers so that they have equal strength normal to and along the line, and to connect the strands to the insulators in such a manner that the towers are safe in the case of their breaking. In pyramidal towers for three strands the torsion arising from the breaking of a side strand produces considerable strains in the diagonals and lateral struts near the top; these can be made larger than required for the forces acting normal to the line with but slight increase in the cost of the towers.

There are generally built at least two lines of three wires each. The cheapest way is to carry the two lines on one row of towers. A safer way with 60,000 volts is to build two separate rows of towers each for one line.

To secure the same safety as in buildings and bridges, the unit strains customary in their design (for dead and wind loads) must be adopted. For medium steel of 60,000 to 70,000 pounds ultimate strength and 36,000 pounds elastic limit, a unit strain of 20,000 pounds per sq. in. net section can safely be taken in tension and one of $20{,}000 - 80\frac{l}{r}$ per sq. in. of gross section in compression (l being the unsupported length of the struts and r their radius of gyration).

There exists no uniformity of practice in regard to the subjects discussed in the foregoing. In the calculation of the proper deflection some advocate for copper strands a wind pressure of 10.5 pounds per sq. ft. of wire without ice (they claim that no ice is formed on power transmission wires) and a unit strain of 40,000 pounds per sq. in.; others advocate a wind pressure of 25 pounds per sq. ft. of ice-covered wire with 1/2-in. thick coat of ice and a unit strain of 20,000 pounds per sq. in. With a 350,000 c. m. strand of 0.67-in. diameter and the former assumption the wind pressure per lineal ft. of wire is 0.59 pounds, with the latter it is 3.38 pounds. The weight is in the former case 1.05; in the latter 1.8 pounds per foot. The resultant force normal to the line is in the former case $\sqrt{0.59^2 + 1.05^2} = 1.20$ pounds; in the latter $\sqrt{1.8^2 + 3.38^2} = 3.83$ pounds. The assumed force in the latter case is three times and the permissible unit strain one-half that in the former. The required deflection at minimum temperature with the assumed wind pressure and ice is six times and the maximum deflection is more than twice as much in the latter as in the former case. Both are advocated by prominent electrical engineers. The former assumptions more closely agree with the common practice; the latter have been the basis of a line built near Niagara Falls. In regard to the forces acting along the line there is equal or even greater divergence of opinion.

The calculation of the proper deflection for aluminum conductors is similar to that given for copper. The elastic limit of the stranded conductors now exclusively used is 14,000 pounds per sq. in., the ultimate strength 26,000 pounds, and the modulus of elasticity 9,000,000 pounds; the coefficient of linear expansion is 0.0000128 per degree Fahrenheit. The specific gravity is 2.68 and the conductivity of conductors 99% pure is 62% that of pure copper. If we take a line made up of three strands each of 560,000 c.m., which is about of the same conductivity as the copper line of our previous example, we have a 7/8-in. strand of 0.44 sq. ins. The calculation, assuming the same thickness of ice, the same wind pressure per square foot, and the same factor of safety, gives for a 660-ft. span a deflection of 27 ft. 8 ins. as against 20 ft. with copper conductors of the same capacity. Mr. F.O. Blackwell found for hard drawn aluminum cables a modulus of elasticity of 7,500,000 pounds. If this is used instead of 9,000,000 pounds taken above the maximum deflection becomes 27 ft.

(To be Continued.)

An agreement has been reached before the Board of Railway Commissioners between the representatives of the Ontario Power Company, of Niagara Falls, and the Grand Trunk Railway Company with reference to the carrying of the company's high-voltage wires over the railway company's tracks. The power company undertakes to use light steel bridges for supporting the wires, with a span of 56 ft. over single tracks and 76 ft. over double tracks. Where telegraph wires are outside the ends of the bridge, they are to be protected by guard wires with a 24½ ft. clearance from the rail of the bridge. The Grand Trunk Railway Company waives its objections to the turning on of the current immediately, the power company to assume all responsibility for accidents.

ELECTRIC SMELTING OF IRON ORE

Dr. Eugene Haanel, Dominion Superintendent of Mines, gave a highly instructive address before the Canadian Club at Toronto on March 12th on "Electric Smelting of Iron Ore." Dr. Haanel has been intimately connected with the experiments at Sault Ste. Marie, Ont., conducted under Government supervision, and which have demonstrated beyond a doubt the practicability of the electro-thermic process. After dealing with the European experiments and the peculiar distribution of the raw material in Canada, he gave the following account of the Sault Ste. Marie experiments:

For the successful introduction of electric smelting of Canadian ores the following points which could not be settled by the European experiments required demonstration:

Could magnetite, which is our chief ore, and which to some extent is a conductor of electricity, be successfully smelted?

Could iron ores with considerable sulphur contents be made into pig iron of marketable composition ?

Could charcoal, which can be made from mill refuse and other available sources of wood useless for other purposes, be substituted for coke, which must be imported?

And, lastly, what was the exact amount of electric energy required per ton of pig iron produced?

To properly investigate these problems a sum was set aside by the Government, and the work undertaken by Dr. Heroult, of La Praz, France.

The Lake Superior Power Company of Sault Ste. Marie offered a building in which to erect a plant, and the use of one of their alternators of 300 electric horse power capacity, free of expense for four months. The offer was accepted.

The experimentation on Canadian ores began in earnest the middle of February, the furnace being in operation night and day, with some intermissions, until March 5. During that time about 150 casts were made, yielding about 55 tons of pig iron. For the first experiments the ores employed were hematite, such as used by the Algoma Steel Company in their blast furnaces; for the remainder of the experiments different classes of Canadian magnetite from the different sources of supply, all of high sulphur contents, with the exception of the Wilbur magnetite, which was low in sulphur, were employed.

Even the first experiments with magnetite showed that our fears had been groundless and that magnetite could be smelted with as much facility as hematite and with an output equal to that of the best experiment made with hematite.

Analysis of the iron produced by charcoal soon proved that, although the slag was not particularly basic, the sulphur could be caused to pass into the slag, resulting into a pig iron containing a few thousandths of one per cent. of sulphur."

In every instance the output was far greater, in several instances one-third greater, than the figures adopted by Mr. Harbord in the report of the Commission on Electric Smelting.

Experiments with roasted and briquetted nickeliferous pyrrhotite, containing 1.6 per cent. of sulphur, were equally successful, furnishing a ferro-nickle iron pig containing 4½ per cent. of nickel, and virtually free from sulphur. The estimated value of this product was $40 to $44 a ton. So succesful have these experiments proven that the Lake Superior Power Corporation have decided to acquire the Government plant for the purpose of converting their stock of briquetted ore into marketable ferro-nickel pig.

One of the most important points in the investigation which could not be successfully settled by the experiments at Livet was the consumption of the electrodes, and it was found that the consumption was beyond expectation small, and that an electrode which had been in use for three weeks, and during that time had been exposed to free air in an incandescent state for many hours, and had been used for melting down charges, which is always attended by waste of electrode without corresponding output in metal, that even with this severe test the consumption per ton of pig iron produced was between 15 and 20 pounds. According to Mr. Herault's estimates, this means an outlay of 30 cents per ton of pig iron.

Many of our magnetites are too high in sulphur to be handled by the blast furnaces, and consequently have so far been of no commercial value. But the very best of pig iron, as has been proven, can be made from ores which contain as high as one per cent. of sulphur. A blast furnace will not usually handle an ore which contains one-tenth of one per cent. of sulphur and requires therefore an ore which cannot be got at a low figure. The Algoma Steel Works pay, I understand, $4.50 for the hematite ore which they use in their blast furnaces. A pig iron equal in value and lower in sulphur contents can be made by the electric process from sulphurous ores which could be bought for $1.25.

Regarding water power required for the application of this process, it may be stated that many water powers exist in Ontario surrounded by iron ore fields in localities ill adapted for the application of electric energy for any other purpose, and could be developed to furnish an electric horse power a year from $4.50 to $6.

With such a price for the energy required, the small consumption of electrode, the cheapness of ore employed, and the peculiar excellence of the pig iron produced, electric smelting of iron ores in Canada, using charcoal or peat coke made from our peat bogs of enormous extent, may be pronounced a commercial success. Under the prevailing conditions in Canada it now only remains for the engineer to design a plant on a commercial scale, say of 100 to 150 tons daily output, with all the necessary labor-saving appliances. Just as in the case of the blast furnaces, so likewise with the electric furnace, experience gained will result in further economy, and the day may not be far distant when the carbon monoxide, which is of high calorific value, and which at present, as a product of the reaction taking place in the electric furnace, is allowed to escape without utilization, will be employed for increasing the output by at least a third or half. If that should take place the blast furnace could not compete

with the electric furnace even under the conditions where coke might be cheaper than at present quoted in Ontario and Quebec.

A further advantage of the electric process is that the units employed are comparatively small and cheap of construction. A unit of 1,500 h.p. is perhaps the largest that under present circumstances should be constructed. Such a unit would have an output of about 18 tons per day and corresponds in size to about the larger Swedish charcoal blast furnace. With the present advance which has been made in the transference of electric energy, batteries of electric furnaces could be set up at various iron ore deposits which could be fed with electric energy from some centrally located water power, thus effecting a saving of the transportation costs of the ore from the mine to the furnace.

When a deposit is worked out the furnaces may be moved to the next deposit, simply lengthening the wires which carry the high tension current to the transformer of the plant."

The utilization of ores of high sulphur contents which cannot be used in blast furnaces is of especial importance, because the question has arisen how long the present supply of blast furnace iron ores is likely to last, and when these ores are exhausted and none but sulphurous ores and titaniferous ores are available, the stacks of numerous blast furnaces will be silent and smokeless, having been supplanted by the electric furnace, which can successfully heat an ore which blast furnaces cannot handle.

RESULTS OF EXPERIMENTS.

The following is a summary of the results of the experiments which have been completed under Government auspices at Sault Ste Marie:

1. Canadian ores chiefly magnetite can be economically smelted by the electro-thermic process.

2. Ores of high sulphur contents can be made into pig iron containing only a few thousandths of sulphur.

3. The silicon contents can be varied as required for the class of pig to be produced.

4. Charcoal which can be cheaply produced from mill refuse or wood which could not otherwise be utilized, and peat coke made from peat, of which there are abundant deposits in Ontario and Quebec, can be substituted for coke without being briquetted with the ore.

5. A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickel ferroes pyrreholite.

6. Pyrite cinders, resulting from the roasting of pyrite in the manufacture of sulphuric acid, and which at present constitute a waste product, can be smelted into pig iron by the electric process.

7. Titaniferous iron ores containing up to 5 per cent. can be successfully heated by the electro-thermic process.

The result of the introduction of electric smelting into Canada may be summarized as follows:

(1) The utilization of our extensive water power, which cannot at present be profitably employed for any other purpose.

(2) The utilization of the large number of iron ore deposits which, on account of their high sulphur contents, cannot be treated by a blast furnace, and have so far been valueless.

(3) The utilization of our extensive peat bogs for the production of peat coke, to be used as reducing material for the operation of electric furnaces, and the utilization of mill refuse and sawdust, for which there has been so far no practical use.

(4) Rendering Canada independent of fuel import for matallurgical processes.

(5) Enabling Canada to produce her own pig iron from her abundant sources for home consumption, and consequently retaining in our own country the money which otherwise would have to be sent abroad to purchase pig iron in the crude and manufactured state.

(6) The development of steel plants and rolling mills using only electric energy.

PUBLICATIONS.

"Westinghouse Type SA Motors" is the title of a recent pamphlet issued by the Westinghouse Electric & Manufacturing Company.

A small booklet published by the Canadian General Electric Company describes the Edison primary batteries and gives general directions for charging same.

The third of the Allis-Chalmers-Bullock series of monthly calenders showing the coats of arms of the different provinces of Canada has been issued, and is, like the former ones, quite artistic.

The Westinghouse Company's Publishing Department have recently sent out two booklets of general interest. One is entitled "Gas Power in Electric Railway Work"; the other "Gas Power for High Pressure City Fire Service".

The booklet containing the joint annual report of the Niagara, St. Catharines & Toronto Railway Company and the Niagara, St. Catharines & Toronto Navigation Company, Limited, is one which is deserving of special mention on account of its attractive appearance. A high grade of paper and perfect letter-press combine to secure this result. Mr. Frederic Nicholls is president of these companies, Mr. E. R. Wood vice-president, and Mr. E. F. Seixas general manager.

The subject of transformers is somewhat extensively treated in the latest catalogue received from the Pittsburgh Transformer Company. In this book are illustrated and described the various styles of transformers which they manufacture, including sizes from 6-10th kilowatts to 50 kilowatts capacity and in voltages up to 50,000 volts. An interesting photograph is shown of a Pittsburgh transformer struck by lightning, the cover being burst off but the converter still operating as well as the day it was installed.

An important work upon steam turbines, by Messrs. T. Stevens and H. M. Hobart, giving the most recent results in practice and having a succinct account of the latest types, will be issued by Messrs. Whittaker & Co. this month. It will contain exhaustive comparisons between steam turbine and piston engine economies, and from the results rational conclusions are formulated as to the respective cases in which these two types of prime movers should be employed. Weights, costs, speeds, number of wheels and blades and other leading data of various types are contrasted in tabular form. More complete details than have been published before of many of the most recent steam turbine generating stations on both sides of the Atlantic are included, with a unique series of comparative tables. Marine steam turbines are similarly dealt with in some 100 pages, and fuller information than has before appeared is tabulated in form for the readiest reference. The work will extend to some six hundred pages and will be well illustrated.

Mr. Norman Berry, Winnipeg, Man., who has been connected with the installation of electric machinery for the Lac du Bonnet Power Company for some months past, has gone to Rio de Janeiro, South America, where he takes a similar position for the Rio de Janeiro Tramway, Heat & Power Company, of which Mr. Wm. Mackenzie is president.

Western Canada

A MODERN MUNICIPAL LIGHTING PLANT.

Calgary's new municipal electric lighting plant is one of the most up-to-date and best equipped plants in the Dominion. The power house is 40 x 110 feet, solid brick on a stone foundation, a solid brick fire wall inside dividing the boiler room from the generating room.

In the boiler room are two 250 h.p. Babcock & Wilcox water-tube boilers, equipped with rocking grates and Granger steam jet blowers. The smoke-stack was supplied by the Robb Engineering Company, of Amherst, N.S. It is 5 feet in. diameter and 80 feet high, set on a concrete base 19 feet high above ground, the inside being lined with fire brick.

The engine, which is direct connected to the generator, is a 350 h.p. Robb-Armstrong Corliss cross compound, the cylinders being 18 and 32 inches. It is equipped with the latest design valves, oiling arrangements, etc. The fly wheel is 10 feet in diameter, weighing eight tons.

The generator, which is of the Allis-Chalmers-Bullock type, is a 260 k.w., 3-phase, 2,200 volt, a.c. revolving field machine, with a 12 1/2 k.w. exciter. The whole apparatus, generator and engine, is set on a solid concrete foundation, as also are the boiler feed pump and heater, the latter being situated under the main floor.

The switchboard is a three panel board, equipped with generator, feeder (or line) and arc light panels. The generator panel is mounted with three a. c. ammeters; one d.c. ammeter and one a.c. voltmeter; plug switches for ground detector and voltmeter; the necessary field switch and rheostat mounting for exciter and generator; and 3-pole automatic oil switch between generator and bus-bars. The feeder or line panel has two a.c. ammeters and two automatic oil switches for control of 3-phase circuits. The arc light panel has the necessary ammeters and plug switches for the control of three arc light circuits of 35 light capacity each. The regulators for the arc lamps are of the improved Adams-Bagnall type, with the necessary step-up transformers for the full load of 35 lamps for regulator.

The pole line consists of about 700 poles, distributed throughout the city, for carrying the arc circuits, 3-phase circuits and other necessary distribution. The arc lamp circuit is divided in three, one feeding the southern portion of the city and the other two the northern part where the greater number of lamps are at present required. One hundred arc lamps are at present installed.

The two 3-phase circuits are for incandescent lights and extend from the power house direct to centres of distribution on the north and south sides of the city, from which centres single phase circuits are run out to the various points where the full 3-phase is not required.

It might be mentioned in passing that all the wires in the power house are contained in ducts and a pit under the floor built to accommodate them.

All the electrical equipment was supplied by Allis-Chalmers-Bullock, of Montreal, and installed by Mr. A.C. Reed. Mr. McKenna, of the Babcock & Wilcox Company, had charge of the installation of the boilers, while Mr. Bogard, of the Robb Engineering Company, looked after the setting up of the engine and smoke-stack. The whole work was under the personal supervision of Mr. E. Lionel White, Calgary's city electrician, Mr. Thorold, the city engineer, having designed the building.

THE LAC DU BONNET ELECTRICAL PLANT.

In 1901 the Winnipeg General Power Company were incorporated for the development and transmission of power to the city of Winnipeg. This Company was in 1905 consolidated with the Winnipeg Street Railway Company, a company operating all of the tramways as well as the lighting and general power service for the city.

The site decided upon for the power house was at Lac du Bonnet, which is on a branch line of the Canadian Pacific Railway. The power is obtained from the Winnipeg river, which was dammed eight miles from the power house. The canal is 125 feet wide and 9 feet deep, having a drop of 5 feet per mile, giving a head of 40 feet for operating the water wheels.

Many difficulties were encountered in constructing the canal, on account of the large amount of granite which had to be blasted out with dynamite and the pieces of rock taken out by means of hoists. The amount of rock blasted was in the neighborhood of 450,000 cubic yards.

The first survey was made in 1901 and the work on the power house was begun in 1903. The power house is steel and brick and contains four 1,000 k. w. and five 2,000 k. w. generating units; two 175 k. w. motor driven exciter sets and two 100 k. w. water driven exciter sets. The generators are water wheel driven, the turbines being of the McCormick type manufactured by S. Morgan Smith, of York, Penn. The switchboard is of black slate and of the bench type, located on a gallery in the centre of the generator room. All instrument cables are run in iron conduits to the switches, which are of the oil type, and built in pressed brick cells.

The transformers consist of six 830 k.w. and nine 1,800 k.w. 40,000, 50,000, and 60,000 volts on the primary side and 2,200, 2,300, and 2,400 volts on the secondary side. All transformers are connected in delta on both the high and low tension. The high tension buses are protected by three inch concrete slabs and on 6,000 volt insulators. There are two transmitting lines, on steel towers, protected by Horn type lightning arresters, for conveying the power to the sub-station at Winnipeg, the distance being about 65 miles.

The sub-station at Winnipeg is laid out similar to the Lac du Bonnet power house. The transformer capacity consists of nine 800 k. w. and six 1,800 k. w. transformers, 55,000, 44,000, and 33,000 volts on the primary side and 2,300, 2,200, and 2,400 volts on the

secondary side. The switchboard is of blue Vermont marble.

The ultimate capacity of the station for railway and direct power purposes will consist of eight 1,700 k. w. motor generator sets, of which four have already been installed.

All of the conduits at the sub-station are run in the floor and brick wall to man-holes at points of distribution.

The electrical apparatus was furnished and installed by the Canadian General Electric Company and the material for the towers by the Canada Foundry Company.

The consulting engineer for the work was Dr. F. S. Pearson, of New York.

ELECTRICAL APPARATUS FOR THE YUKON.

The Yukon Consolidated Goldfields Company, Limited, have contracted with the Canadian Westinghouse Company for the following electrical apparatus to be used in gold dredging in the Yukon Territory: Three 100 h.p., 3-phase, 60 cycles, 400 volts, type F motors; three 15 h.p., 3-phase, 60 cycles, 400 volt, type F motors; three 50 h.p., 850 r.p.m., 3-phase, 60 cycles, 400 volt, constant speed induction motors; three 30 h.p. motors; three 20 h.p., 1,120 r.p.m. motors; three 15 h.p., 850 r.p.m. motors; three 7½ h.p., 1,700 r.p.m. motors; nine 75 k.w., oil insulated, self-cooling transformers; two 625 k.w., 3-phase, 60 cycles, 2,200 volts, 415 r.p.m., a.c. generators, and two 17 k.w., type S exciters for same; one 4 panel switchboard for controlling above; four 250 k.w., oil insulated, oil cooled transformers and four 200 k.w. transformers, same type.

ARTISTIC DECORATIVE WORK.

The electrical decorations of the Assembly Hall, Victoria, B.C., on Feb. 2nd, the occasion being the "Native Sons" ball, were very artistic and worthy of note. In the large hall where the dancing took place, the decorations were designed to depict a snow scene, the ceiling being a mass of cotton batting, representing snow, while interspersed here and there were large clusters of electric light with shades representing snow drifts.

Around the walls and balconies were large sprays of white enamel fixtures with white frosted lamps, the body of the walls being done in panelled ivy, the combination giving a charming white and green effect. There were altogether about 1,000 extra lights in the room. The whole design was originated and carried out by Chief T. Watson, of the Victoria Fire Department.

The Montreal Copper Company have recently received an order from the New York Air Brake Works for 100,000 pounds of ingot copper, which is one of several orders from the same firm. They are making large shipments to the United States, which produces about 70 per cent. of the world's supply of refined copper. They claim for this copper superiority over the ordinary brands. Owing to its purity, four carloads were ordered by the Chinese Government for the new coinage system. It is used by the Grand Trunk, Canadian Pacific and Intercolonial Railways and by some of the largest concerns in Europe. This company have the only refinery in Canada and its first production of ingot copper was on February 3rd, 1904.

TELEGRAPH and TELEPHONE

Mr. Charles Toull, inspector for the Bell Telephone Company in Stratford district for the past few years, has been appointed manager at Ingersoll.

The Bell Telephone Company are seeking legislation to empower them to increase their stock from $10,000,000 to $50,000,000, for necessary extension of lines throughout the Dominion.

The Yarmouth Telephone Company, with a capital stock of $9,000, have given notice that they will seek incorporation to construct and operate telephone lines in the County of Yarmouth, N.S.

The Marine Department at Ottawa have decided to establish three Marconi stations on the Pacific coast. They consider that these will be sufficient to cover the whole coast, as messages can easily be sent 400 miles.

The Bell Telephone Company are making preparations for installing their system in Hamiota, Man. They expect to have the local system in operation in a few weeks and long distance connections made early in the spring.

Mr. Henry Rustin, of Omaha, Neb., who displayed such marvellous skill with the incandescent lamp at the Pan-America and Louisiana Expositions, died February 27th. Mr. Rustin was born in Omaha in 1865 and was a graduate of the Sheffield Scientific School at Yale.

The St. Marys, Kirkton and Exeter Telephone Company, Limited, has been incorporated, with a capital of $40,000, to operate in the counties of Perth, Middlesex and Huron. The head office of the company will be at Kirkton. Among the directors are Messrs. W. R. Carr, E. N. Shier, and A. Brethorn.

The Grand Manan Telephone Company has been incorporated, with a capital stock of $2,000, to establish and operate a general telephone business in the parish of Grand Manan, N.B. Among the promoters are Messrs. Geo. E. Dalzell, Alex. Small and J. S. Richardson, all of Castalia, N.B.

The special committee of the Manitoba Legislature who have been investigating the telephone question, have submitted their report, urging the Government ownership of all long distance telephone lines, and also municipal ownership of local systems, the latter to be operated in conjunction with the Government long distance lines.

Mr. John D. Copp, of the Marconi Wireless Company, in a recent visit to Sydney, N.S., stated that arrangements had been made for the installation of a wireless station on the Bruce, and that it was probable a Marconi station would be erected on Sydney Harbor for the convenience of the Bruce and Allan line steamers calling there this summer.

The C.P.R. purpose making great extensions in their telegraph system in the North-West during the coming season. Chief among these undertakings will be the linking of a wire from Winnipeg to Saskatoon and thence to Edmonton. The other important extension will be the stringing of a wire between Winnipeg and Regina via Arcola.

The Grand Trunk Railway are preparing estimates as to the cost of installing a telephone system on all their lines. At present the company have Bell telephone lines reaching all their offices and nearly all their stations in Canada. It is estimated that the cost will be upwards of $150,000, but the expense after the service is installed will not be large compared with the cost of the present service.

The British Columbia Telephone Company have ordered a cable 1,800 feet long, at a cost of $3,000, which is to be laid under the First Narrows to connect Vancouver and North Vancouver. The North Vancouver service will be independent of the Vancouver service, as an exchange will be opened across the Inlet and conversations between the two points will be subjected to the long-distance toll. It is estimated that the installation of the service in North Vancouver and the connecting of the lines there with the rest of the long-distance connections of the British Columbia Telephone Company will cost between $15,000 and $20,000. The North Vancouver residents understand that they will be in possession of this service about May 1st.

ELECTRIC LIGHTING OF A SMALL CITY OR TOWN

By F. A. Cambridge, City Electrician, Winnipeg.

The lighting service of a small city or town is often a more difficult problem than that of a larger one, partly for the reason that usually the business or "load" of the plant is very scattered; the amount to be expended on street lighting is limited, and there appears little prospect of a satisfactory day load being forthcoming. For these reasons the standing charges of the plant are apt to be higher in proportion to the connected load than in the case of the larger city.

At the outset the writer would affirm that whether the plant is to be a municipally owned, or privately controlled, one, the services of a thoroughly competent and disinterested consulting engineer should be retained, and his advice acted upon—not simply in the first layout, but also in subsequent extensions or enlargements of any moment. It rarely comes about that the powers that be, whether municipal councils or boards of directors, will, in a plant of this size, engage and retain the services of a man as manager or superintendent, thoroughly competent to deal with all problems of both a business and mechanical or electrical nature—consequently through false economy a "cheaper" man is placed in charge, and in too many cases the plant appears in a few years' time a thing of shreds and patches—costly experiments and mistakes having been carried out and no set plan or purpose followed.

The design of the plant in a growing town should be such that it can be enlarged from time to time and yet retain evidences of more forethought than afterthought—the building of such a design that its symmetry and usefulness will not be impaired or destroyed—ample room having been obtained at the outset not only for the building and its inevitable enlargement but also for storage and other purposes. The type of apparatus to be installed, also the size of the units, the voltage to be carried, these should all be considered from the standpoint of future growth as well as present efficiency. In a plant of this size with the amount of money and business available "scrapping" is apt to be a more serious consideration than in the larger city.

It will in the long run be found desirable for all parties that as steady a load as possible be placed upon the plant—with this in view the matter of furnishing power for pumping the town water supply is well worth considering. The success of motor driven centrifugal or multi-stage rotary pumps is established, so that the operation of the pumping system from electric power will usually be found advantageous. In the case of a privately owned plant the town should not only be able to contract for power at a favorable rate but should also be able to make better terms for street lighting. The furnishing of a day load is not only of advantage to the plant but is a convenience to the citizens, and if the merits of electric power for numerous industries are duly set before the public, manufacturing is encouraged and growth assured in many directions. If the pumping is a direct system the operation of the units for the ordinary domestic pressure can be operated and their consumption of current measured. For a fire pressure a centrifugal "booster" driven by a separate motor can be applied, the current for which can be separately metered. Or, a rate per million gallons pumped could form the basis of charge.

In the case of a municipally owned plant it will usually be found advantageous to combine the water and light plants in the one building, particularly if a steam plant is installed. In this case the building should be fireproof throughout, the boiler, engine and dynamo rooms separated by suitable division walls, and the dynamos and switch-boards and other electrical apparatus installed on a higher level than the water plant, so that in case of any accidental flooding no damage would be likely to be caused to the former.

Should the town favor the granting of a franchise to a company or individual, the contract for power and street lighting should be for not less than a term of five years. No one should expect as favorable a rate under a short term contract as one having reasonable duration. Street lighting apparatus is special and cannot be used for any other purpose after the contract is taken away. A clause should be inserted, however, that "in case the maximum number of lights is increased at the expiration of .... years beyond the number now contracted for, the town should be entitled to a reduction in the price per lamp per night." In this way one of the benefits of decreased cost of operation as the load increased would accrue to the town, and in this way would stimulate the installation of additional lamps and a more liberal appropriation for street lighting.

As to the system of illumination for street lighting—the business streets should be lighted by arc lamps, also any bridges, railroad crossings and the like. For residence streets and infrequently travelled roads 32 c. p. or 50 c. p. series incandescent lamps will be found to be a satisfactory illuminant. By their use a given appropriation can be made to give reasonably good lighting over a larger area than if arcs only are used. The lamps spoken of should not be confounded with the ordinary incandescents so often seen and so seldom giving effective results. The writer has had in operation a number of the above lamps for a considerable period and has found their use most satisfactory.

The installation of the constant current transformer fed from the constant potential alternating generators will usually be found to furnish a satisfactory medium for arc lighting—the closeness of their regulation enables the plant to operate both series enclosed arcs and series incandescents on the same circuits with excellent results.

Regarding a schedule for street lighting—in a town of this size a Moonlight Schedule is usually ample. If the town is operating the plant considerable economy can be arrived at by operating in this way; shutting down for an increasing number of hours as the moon nears "full," with little or no lighting for a night or two each side of full moon and shutting down after that when moon is well up for a number of nights, will furnish very fair service (if administered with discretion). The station operators, however, should keep a lookout for heavy clouds and start up, otherwise constant complaints will come in. If the plant is a private one, the town might with profit arrange a contract on the basis, of, say, 3000 hours of lighting for the year, following a schedule similar to above. In this case an officer of the council should be empowered to order lights on at any time. The hours run could be checked by Bristol recording ampere meters in each circuit and any deductions or extras allowed at the year's end. With other suitable provisions as to outages, etc., the above should form a satisfactory form of schedule.

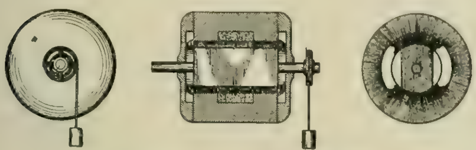
Whether the plant is municipally owned or not, nothing but a meter system as a basis of charge for commercial and domestic service should be thought of. The smaller plants are too apt to begin operating with a flat rate system of charges, and when the inevitable day comes when the meters have to be used a great deal of dissatisfaction is brought about which would have been avoided by adopting a more sane method at the start. Considerable study should be given to the matter of rates and discounts, as all business is not of the same value to the plant.

If the plant is to be operated by the town, the entire system should be placed in charge of a competent man—not only from an electrical standpoint but also from the business point of view. He should be given an absolutely free hand in the employment of his help and their discharge, and whether he is responsible to a board or committee or to members of a commission, he should have something to say in the awarding of all contracts. All suggestion of politics should be rigidly excluded and every encouragement given to men who show a disposition to perform a little more than their duty. Complete and reliable records and account should be kept of all details of operation and expenditure, and every item rightly chargeable debited to the lighting system. If this is done there will be less question as to actual cost of operation.

In reference to the much discussed matter of depreciation, the writer would prefer, in the case of municipal plants, to have a fixed percentage set aside each year and placed to the credit of the plant, out of which repairs and replacements could be cared for. If there is a bond issue with sinking fund set aside annually, this will usually take care of any reasonable depreciation through obsolescence. The above is, it is believed, more satisfactory than taking care of repairs and replacements as they arise—spasmodically—which is apt to throw an undue burden on the plant at intervals—possibly little at the beginning and inevitably more later on. In some municipally owned systems this percentage is added yearly to the actual cost, in others it is not shown at all, but repairs and maintenance charged up to the operating account. In others due provision is made for sinking fund payments, while in others the capital expenditure is not raised by debentures but is provided out of current revenues. The writer believes the method suggested would prove a satisfactory way of dealing with the question, but in many instances the financial arrangements of towns or cities do not allow of any credits being carried over from year to year, making it necessary for those in charge to smooth out the peaks of the financial load by endeavoring to meet these expenditures in as systematic a manner as possible.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

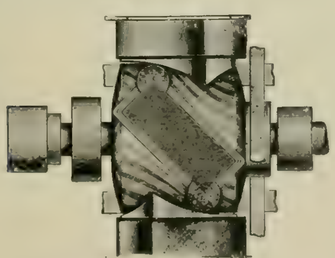
Constant-Current Transformer.—An alternating-current regulator which possesses the distinguishing feature of employing no moving coils forms the subject of a United States patent issued to H. J. Blakeslee. The regulator consists of a transformer having stationary, primary and secondary coils wound on a cylindrical laminated frame. The primary coil is located in an annular recess in the middle of the frame, so as to encircle the core. The secondary coil is wound upon



CONSTANT CURRENT TRANSFORMER.

polar projections which extend inwardly from each side of the middle of the cylindrical frame. Within the frame is placed a movable core, so mounted upon a shaft that a greater or less amount of flux from the primary threads through the secondary according to the position of the core. The current in the secondary is kept at practically a constant value by the use of a counterbalance fastened to a cord which passes around a pulley on the shaft of the core. The pull of the counterbalance tends to bring the core to the position giving maximum secondary current, and the torque due to the current in the secondary tends to bring the core to the position giving minimum secondary current. Therefore, the core being provided with a properly designed and adjusted counterbalance, the secondary coil can be made to deliver a current of constant value to a circuit of widely varying impedance.

Vertical Shaft Generator.—A patent has recently been issued to Morris Schwartz, of New York, for a new form of electrical generator. As will be seen by the accompanying illustration, the invention has an



VERTICAL SHAFT GENERATOR.

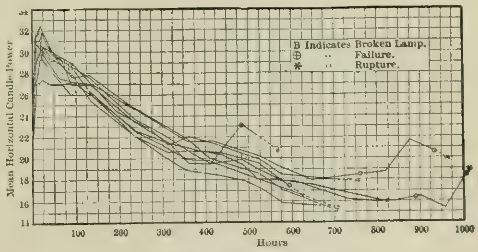
armature mounted to rotate on a vertical axis, said armature having helically-wound conductors whereby said conductors incline, and pole-pieces having their axes inclined whereby they are substantially parallel with the adjacent parts of said conductors. The inventor expects his generator to reduce very materially the cost of producing current for lighting and power purposes.

Tests of Tantalum Lamps.—The following figures and accompanying curves relate to a recent test of ten tantalum lamps fed by direct current. In making the photometric measurements, the lamps were rotated at a speed of about 40 to 50 r.p.m. Automatic voltage regulation supplemented by hand control was used and the average variation of pressure did not exceed ½ per cent. The lamps were burned at rated voltage and the following results were obtained :

	Initial		Broken at			Total life
Lamp No.	cp.	watts per cp.	Hours.			in hours.
*1	24.7	1.94	88			
2	23.5	1.97	890	1007	1013	1013
3	21.0	2.17	760			760
4	22.1	2.06	700			700
5	23.8	1.99	813			813
CANDLE-HOUR PERFORMANCE OF TANTALUM LAMPS.						
6	24.0	2.00	706			706
7	26.1	1.86	712			712
8	25.4	1.81	484	572		572
9	23.2	2.03	596	625		625
10	25.0	1.90	710	939	968	968
Average	23.8	1.98				763

*Lamp No. 1 was accidentaly broken at the end of 88 hours and is, therefore, not included in the average.

With lamps No. 2, 8, 9, 10, when rupture first occurred in the filament it was possible to re-establish the circuit by tapping the lamp, which caused the loosened end of the filament to make contact with an adjacent section, short-circuiting part of the circuit



TANTALUM LAMP CURVES.

This caused a decrease in resistance and a corresponding increase in mean horizontal candle-power. With lamps No. 8 and 9 the filament could be repaired in this way after the first rupture only, with lamps 2 and 10 after the first and second ruptures. The last column in the above table gives the total life whereby the life of the lamp is not considered exhausted until the filament is in such condition that the circuit cannot be re-established.

Incorporation has been granted to the Telegraphone System of Canada, Limited, to purchase all rights in telegraphone patents for Canada and to manufacture and install telegraphone instruments in railroad trains and offices. The head office of the company will be Montreal, Que., and their capital $50,000. Among the promoters are Messrs. F. C. Hirsch, Thos. Hanley and Robert Bartholemew, all of Montreal.

NIAGARA, ST. CATHARINES & TORONTO RAILWAY COMPANY.

The annual report of the directors of the Niagara, St. Catharines & Toronto Railway Company for the year ended December 31st, 1905, is interesting as being the first since the property was purchased by the present shareholders. The company was incorporated in 1899 and acquired a steam road then operated between St. Catharines and Niagara Falls, Ont. This road was reconstructed and electrified and was ready for operation in August, 1900. The following years it was extended to Port Dalhousie. A horse car line running between Niagara Falls, Drummondville and Niagara Falls South was purchased, rebuilt and electrified. Another local line, operating between St. Catharines and Thorold, was purchased in May, 1901, and all the above roads have been amalgamated and operated under one management. The company have made extensive improvements by building new car barns, new station at Stamford, overhauling the tracks and adding new equipment.

The company have made application to the Dominion Parliament for permission to extend their railway from Thorold to Welland and Port Colborne; from Port Colborne to Fort Erie, thence to the city of Niagara Falls; from Niagara Falls or Thorold or Welland to the City of Brantford, and from the City of St. Catharines to Niagara-on-the-Lake.

The company own and operate the two vessels "Garden City" and "Lakeside," and plans are now being prepared for anothor vessel to be ready for service early in 1907.

The general officers of the company are as follows: President, Frederic Nicholls; vice-president, E. R. Wood; general manager, E. F. Seixas; secretary-treasurer, Aemilius Jarvis; assistant secretary-treasurer, C.E.A. Goldman; accountant, D. J. McIntosh; general freight and passenger agent, John Paul.

MOONLIGHT SCHEDULE FOR APRIL.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Apr. 1	11 50	Apr. 2	5 00	5 10
3	0 45	3	5 00	4 15
4	1 30	4	5 00	3 30
5	2 10	5	5 00	2 50
6	2 45	6	5 00	2 15
7	No Light	7	No Light	....
8	"	8	"	....
9	"	9	"	....
10	7 00	10	10 00	3 00
11	7 00	11	11 10	4 10
12	7 00	13	0 15	5 15
13	7 00	14	1 20	6 20
14	7 00	15	2 20	7 20
15	7 10	16	3 10	8 00
16	7 10	17	4 00	8 50
17	7 10	18	4 30	9 20
18	7 10	19	4 30	9 20
19	7 10	20	4 30	9 20
20	7 10	21	4 30	9 20
21	7 10	22	4 30	9 20
22	7 10	23	4 30	9 20
23	7 20	24	4 20	9 00
24	7 20	25	4 20	9 00
25	7 20	26	4 20	9 00
26	7 20	27	4 20	9 00
27	7 20	28	4 20	9 00
28	7 20	29	4 20	9 00
29	10 30	30	4 20	5 50
30	11 20	May 1	4 10	4 50
		Total	....	181 35

IRON CONDUIT.

MONTREAL, March 5th, 1906.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—In the February issue of your paper, on page 46, you refer to a meeting held in the rooms of the Civil Engineers' Society in Montreal, and the writer, among others, was very much surprised to read your account of this meeting, especially that part of your article which refers to iron conduit, and what Mr. R. A. Ross said about it.

How any one could criticize iron conduit at this stage of the situation, when every one in the business knows that it is the only safe and reliable means of wiring any kind of a building; that this form of wiring is employed all over the world, in battle-ships, and, in fact, everywhere, by all who pretend to do good work, and your remarks stating "that Mr. Ross ably handled the question" confirms the belief that the remarks published by you were inspired by some one who has not been able to make a success of interior wiring placed in conduit because other contractors have not been able to underbid this particular party and secure all of the work.

It seems that Mr. Ross had some unsatisfactory experience with iron conduit in one particular building, and when he criticied iron conduit at the meeting referred to, he made a mistake, as his remarks were opposed by every one present who spoke on the subject; there were at least eight different parties who spoke on the subject and they all opposed Mr. Ross' attitude.

Yours truly,

A READER.

[For the purpose of creating discussion on the subject, we publish the above letter, which was unaccompanied by the name of the author, but in future the names of the writers of communications must be furnished, not for publication, but as a guarantee of good faith.—The Editor.]

ELECTRICAL INSPECTION.

MONTREAL, February 27th, 1906.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—I read with interest your letter on Electrical Inspection (Communicated), published on page 34 of your February issue, and can state that you in Toronto are no worse than we in Montreal so far as inspection is concerned.

The Local Union of Electrical Workers are not the proper people, however, to take up such matters: it is one that should be taken up by capitalists, viz., the employers, as they have the most risk at stake; and it is high time that Toronto contractors got together and at last tried to do something, as it seems the Montreal contractors are getting into shape. The proper parties to undertake the inspection are without doubt the insurance companies—not the city nor the power company.

The only thing that a union can do to benefit matters in the event of no satisfaction being secured from the Underwriters by their employers, would be for them to petition the city council to license each wireman. The applicant might be brought before a committee say of five, two being prominent workmen, two being employers, and the third being a city official; it would be possible to get three of these together at any time and the applicant put through an examination and certificate granted as to his efficiency as a first class or second class wireman as the case might be. The city might charge a fee of say $2.00 for each first class and $1.00 for each second class license issued. In this way, as the city is not called on to pay out any money, they would probably jump at the chance of getting some money in, even though it were from workmen who could ill afford it—nevertheless, the sum of $2.00 per annum might prove well invested for them if it safeguarded them from tramp wiremen, who could be arrested and fined as having committed a misdemeanor.

The above suggestion is only in case the Underwriters cannot be brought to realize their responsibility in the matter.

Yours truly,

A MONTREAL CONTRACTOR.

The Erie, London and Tillsonburg Railway will seek incorporation to enable them to construct and operate an electric railway from Port Burwell, along the north shore of Lake Erie to London, with a branch running into Tillsonburg.

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XVI. APRIL, 1906 No. 4.

New Transforming and Distributing Substation at Montreal

BY J. A. BURNETT.

For some time past the problem of economical distribution of power in cities of a quarter of a million and upwards of population has received attention. It was once thought that one central station, with feeders running to centres of distribution, and all switching apparatus concentrated within four walls, was the natural tendency.

FIG. 1. MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

Latterly, it has been considered preferable to build receiving stations at suitable points, send power at, say, 11,000 volts, three-phase underground, and to distribute from these stations at 2,400 volts, three-phase or single-phase overhead. The expense of attendants, interest, etc., when capitalized, has been estimated to be much less than the outlay on ducts, feeders at 2,400 volts, and the value of energy loss as would be necessitated by the first scheme outlined.

The City of Montreal, whose electrical needs are supplied by the Montreal Light, Heat & Power Company, has rather unusual conditions to satisfy. Power is sent in from four sources, as shown in Figure 1. These summarize as following:

Shawinigan Falls	85 Miles	5,000 k.w.
Chambly	15 "	15,000 "
Lachine	5 "	6,000 "
Soulanges	30 "	12,000 "
		38,000 k.w.

The latter development, Soulanges, is under construction. In addition to the above, there is a steam reserve of 6,000 h.p.

The Montreal Light, Heat and Power Company operate some seven stations grouped, as shown in Figure 2. These seven stations are all interconnected by tie lines—the uniform voltage of 11,000 being employed. The station here described is but a step in the plans for consolidating the immense properties of the Montreal Light, Heat and Power Company, which work is being carried on under the supervision of Mr. R. S. Kelsch, consulting engineer of the company.

Between the Shawinigan power station, Orleans

avenue, and the Central station, is situated the Mentana street station, distant about 16,000 feet from each. This station may be fed from Shawinigan station or central station or by both. The tie lines are looped in and either tie line may be opened at will. This is shown on Figure 4, which also shows the general scheme of connecting up apparatus in the station.

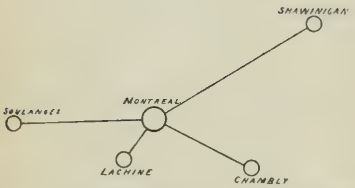


FIG. 2. SOURCES OF POWER, MONTREAL LIGHT, HEAT AND POWER COMPANY.

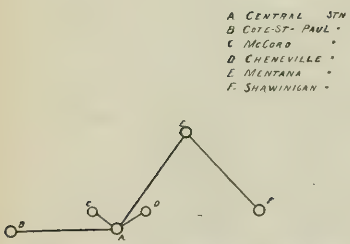


FIG. 3.—SUBSTATIONS, MONTREAL LIGHT, HEAT AND POWER COMPANY.

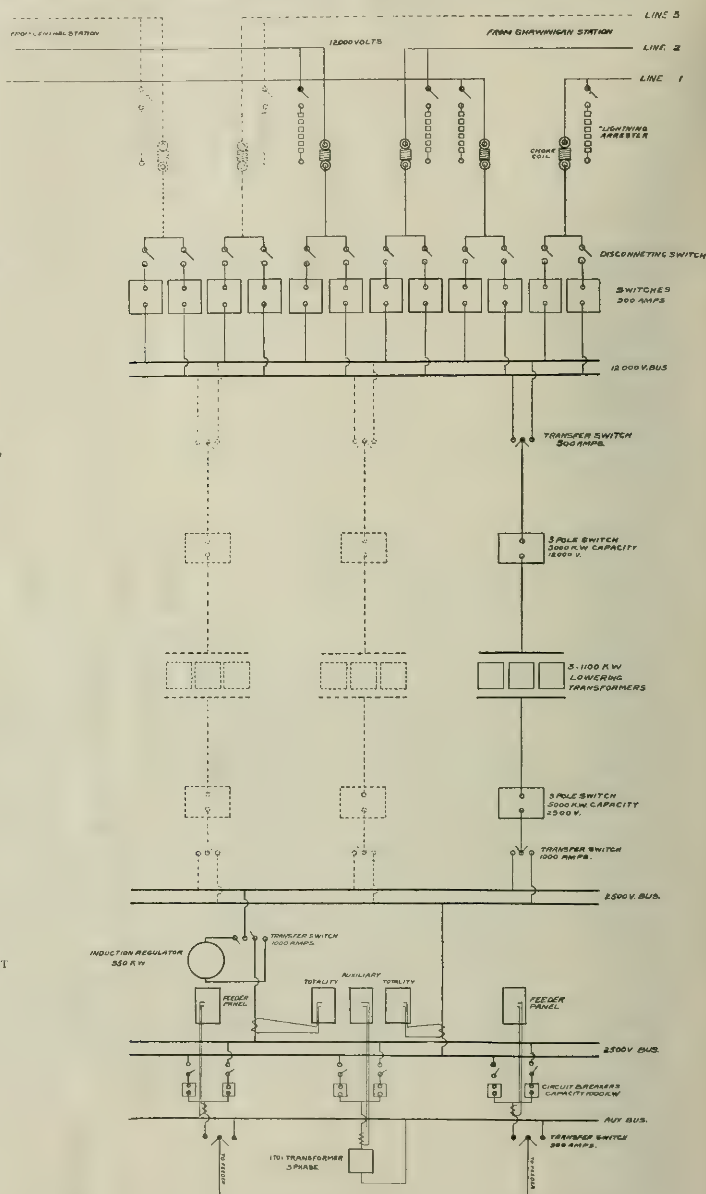


FIG. 4.—DIAGRAM OF LINE CONNECTIONS, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

As the voltage on the tie line may vary between considerable limits, owing to the effects of load at either receiving station, it is necessary to use an induction regulation so that voltage on the substation buses may be regulated at will. Put into other words, the tie line voltage may be dropping, and at the same time it may be necessary to raise the substation busbar voltage in order to compensate for distributing feeder drop.

It may be well, at this point, to describe the building itself, which is of concrete, proportions 1 sand, 3 cement, 5 broken one-inch stone, internal dimensions 60 feet square and 35 feet from ground line to roof. A commodious basement with 9 feet head room is provided, reached by an iron stairway. Wood was eliminated as much as possible, only the main sliding door and porch door being of this material. The sliding door is of the Underwriters pattern, and covered with sheet metal. Windows are of copper frames, and fitted with ¼-inch wire glass, as is also the large roof

monitor or sky-light. The roof, it will be noted, (Fig. 5) drains to the centre, where a down soil pipe runs to the sewer.

The walls contain 2¼-inch vitrified clay duct from basement to point of exit, and each 2,400 volt feeder cable is thus isolated. This is a valuable feature in case of a cable breakdown.

A 15-ton hand crane is provided for handling transformers, blowers and regulator, and for lifting apparatus out of the basement. Two iron covered hatchways are provided under the crane area to give access to the basement, the heavy covers being themselves handled by the crane.

The interior walls were all plastered white, and with the liberal number of windows employed, as well as the light from the roof, the station has a well lighted and pleasing effect at all times. The main floor is 5' thick and contains a network of 1¼ inch wrought-iron cement lined conduit for control wires, something like 2,000 feet being used for this purpose. The illustration (Fig 8) shows those used for connecting up arc apparatus.

Careful attention was given to enclose all current carrying cables in clay duct. Crosses were avoided in open cable work, but were done instead where cables were buried, and consequently isolated from each other.

The station contains seventeen 1,000 k.w., alternating current three-phase 2,400-volt feeder switching units, panels, etc., and 20 50-light alternating current arc transformers and constant current regulators and 2,000/4,000-volt transformers.

A reference to the diagram of connections (Fig. 4) shows that the circuits, three incoming and three outgoing, come into the station through the lightning protection apparatus, thence to knife disconnecting switches, and thence to solenoid operated G. E. type form "F-K" oil switches, from these to knife disconnecting switches, and to a double set of concrete enclosed 11-000-volt busbars. These bars are also sectionally divided, making it possible to operate different sections of station load from two distinct and separate sources of power.

From these busbars, leads are carried to an automatic type H-3 G. E. oil switch, 300 amperes, 13,000 volts rating, thence through current transformers to an open wiring transformer delta connection for primary grouping indicated on Fig. 4. The lowering transformers consist of three banks of three each, 1,100 k.w. air blast G. E. make. The primary windings are adapted for voltage of 9,700, 10,300, 11,000 and 12,100 volts, with taps to obtain either two-phase or three-phase on the secondary winding at 12,100-volt primary. The secondary winding is adapted for either 2,300 or 2,400 volts. The leads are brought up through the base and once in the air chamber, are brought to the clay ducts as quickly as possible. This is shown on Fig. 5.

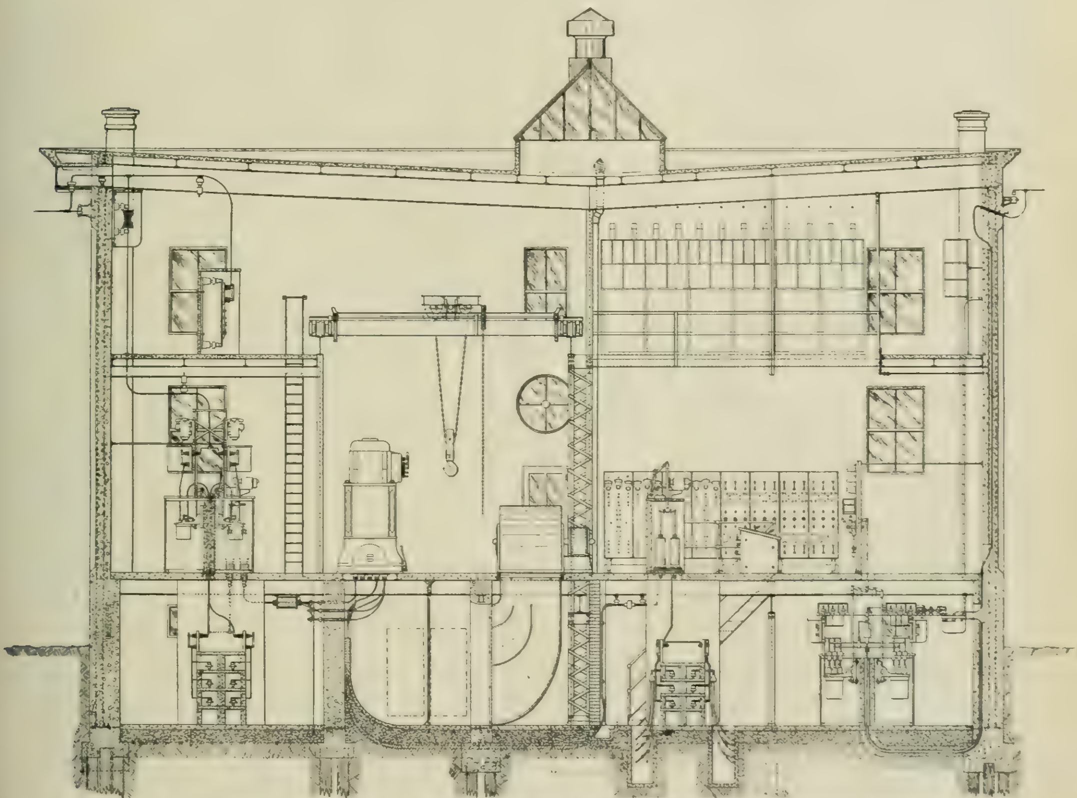


Fig. 5.—Elevation, Mentana Street Substation, Montreal Light, Heat and Power Company.

Owing to the standard spacing of transformers, bringing these large units into such close proximity, it has been found by practical experience that in the event of a transformer breakdown and resulting arcing, the flames are carried by the air blast into the neighboring transformers, resulting in their destruction. To obviate this unsatisfactory result, a cast-iron sub-

base or damper was devised. This stands six inches high and coincides with the base outline of the transformer. A substantial grid, or valve, not unlike that used for steam, was devised, and with a horizontal movement of about three inches the air is instantly cut off. Balanced or butterfly valves have been experimented with, but found unreliable. With the valve above, as adopted, a quick pull on a lever completely isolates a defective air blast transformer. The working faces are, of course, machined and tested for air leads before acceptance. The transformer leads are carried through one side of this sub-base by means of closely fitting bushings. The operating handle is shown in the elevation of transformer, Fig. 5. The upper part of the transformer is provided with pivot knife blade switches to obtain the different primary winding combinations, before mentioned. These transformers have a floor space of four feet five inches square and are eight feet nine inches in height and in weight run about 18,500 lbs.

The air required for cooling purposes runs about 2,700 cubic feet per minute at ¾ oz. pressure. Motor twenty to one. The drop in air pressure under these conditions is neglible.

The use of these air screens is amply justified by the surprisingly large quantity of dirt removed from the pressure side of the screen. This dirt would otherwise be lodged in the numerous interstices of winding and laminations.

A no-air alarm is being devised so that in case a transformer damper is closed through error, a bell rings and notifies the station attendant that such is the case. This should prevent a slow burn out of a transformer due to lack of air, and will be an automatic check on the thermometer temperature readings.

The air is conveyed from the blower sets to the air chamber through steel plate ¼ inch thick housings, stayed at intervals and of easy curves to convey the air into the air chamber without shock or without eddy currents or pockets of dead air. The walls of the air chamber are rounded at point of air inlet, as shown on the floor plan, to accomplish the same result. The air chamber is entered through two air tight metal doors, one being on each side of the air screen and each pro-

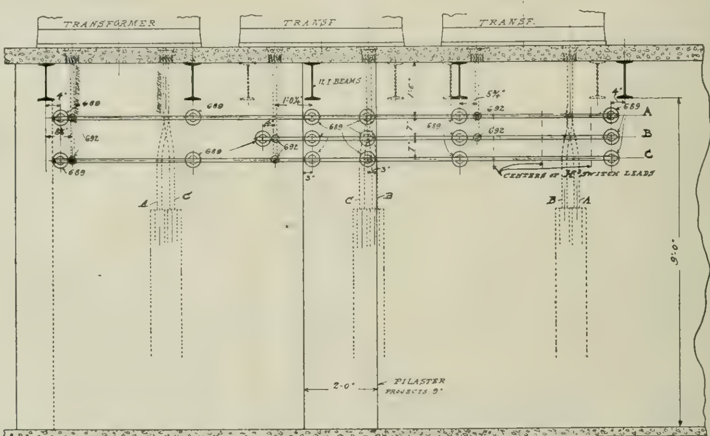


Fig. 6.—Delta Connections, Mentana Street Substation, Montreal Light, Heat and Power Company.

driven fan sets for cooling transformers are provided, three in number, each driven by a 7½ h. p. a.c. 110 volt motor. These are compact and require little attention. The fan is a 60 inch disc and runs at 600 r.p.m. The air is blown down through the main floor and into the air chamber. This is a spacious room, being eight feet six inches wide, nine feet high and fifty-one feet long. An air screen is shown in the section and consists of a series of screens of ½-inch round iron frame covered with 10-inch wire mesh three inch centres. Over this is placed a layer of cheese cloth with edges stitched on the ½-in. iron frame. This is renewed periodically and accumulated dirt removed. The cheese cloth, to a certain extent, cuts down the air head or pressure. This is offset as much as possible by a large ratio of screen to fan opening area. In this case the screen area is approximately 460 feet, whereas the fan outlet area is 22¼ inches by 50½ inches, giving 33.6 square feet for the three fan sets.

Ordinarily two fan sets will furnish enough air for the nine lowering transformers and the induction regulator, which is also of the air blast type, so that the ratio of screen area is 460 to twenty-two or over viding a two-foot three-inch by five-foot nine inch opening. A rubber gasket, which is merely a ⅜ inch draught tubing or weather strip held on by a ⅜ inch x ¼ inch wrought iron bar screwed on, is provided. A brass wing nut tightens up the door, which already has the ¾ oz. per sq. inch air chamber pressure to close it. These doors when accurately made and hung have been found quite satisfactory for the requirements.

The induction regulator, 350 k.w. capacity, with 200 volts ranged up or down, is cooled by air drawn from the air chamber and conveyed to where the regulator is located, thence filtering up through the interior of regulator. The two 12 inch floor beams supporting the regulator are so spaced as to serve as sides of an air duct. A plate was put on top and bottom, thus making an air passage from air chamber proper to the induction regulator. This regulator is automatic and is also compensated for unequal loads on individual legs of circuits. The capacity, 350 k.w., is the nominal rating, but, in reality, the regulator can handle twelve times this amount of power or 4200 k.w. of energy continuously. No duplicate regulator is pro-

vided, but it may be cut out at will by knife disconnecting switches located in the basement. This is shown on the general diagram of connections.

On leaving the 1100 k.w. lowering transformers, the leads are brought single-phase to an H-3 oil switch of 1200 amps. capacity, the delta connection being made just where leads run through the series current transformers. This arrangement eliminates as much as possible any joints, terminal boards, etc., in the air

The distributing switchboard consists of fourteen 1000 k.w. panels two feet wide of blue Vermont marble, and three special panels, two being called totality and one auxiliary. The total station output is registered through the totality panels, which have three ammeters, one indicating and one polyphase recording wattmeter, as well as a voltmeter.

The auxiliary panel is intended to control a static 500 k.w. one to one ratio transformer not yet located

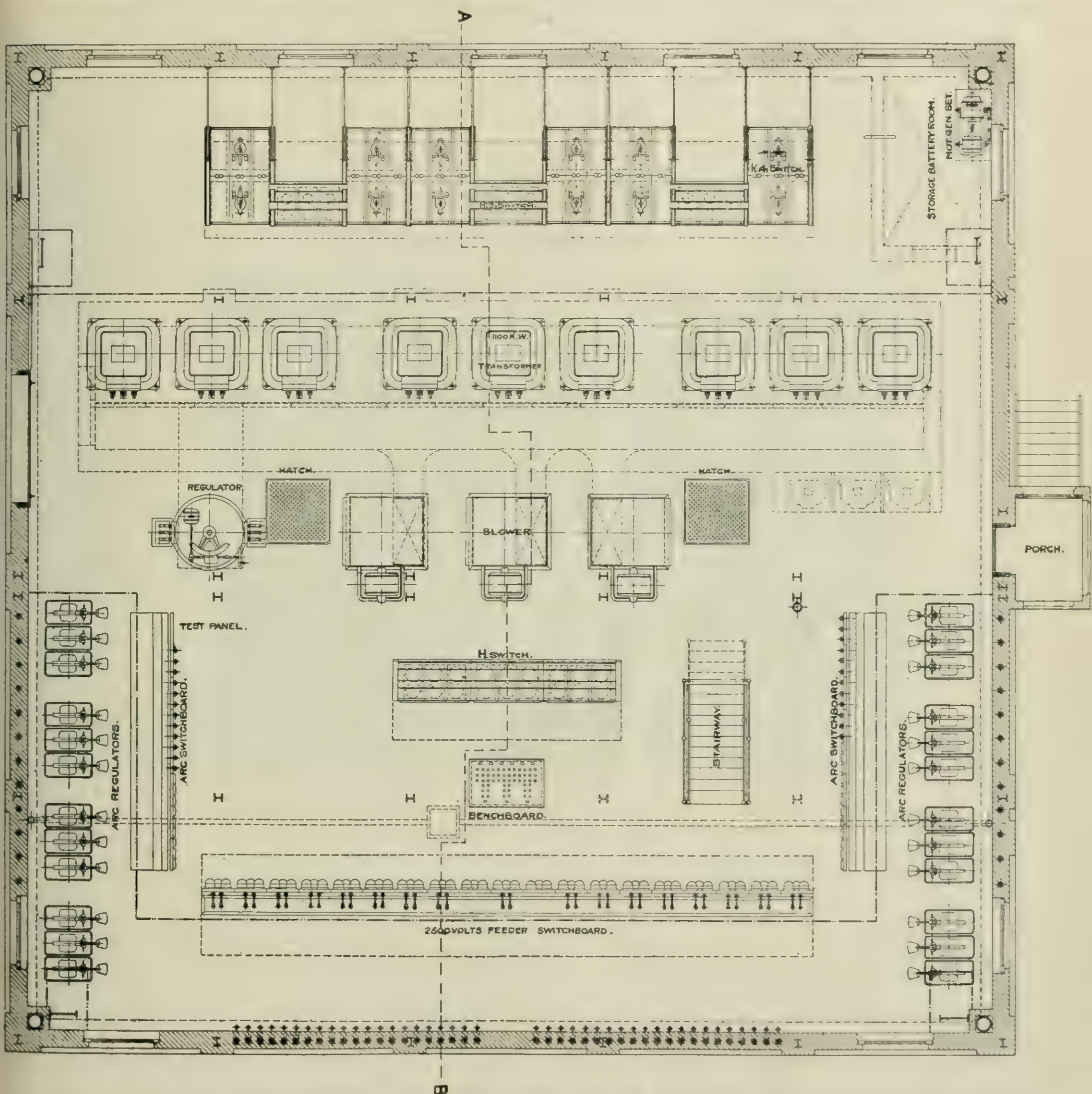


FIG. 7.—DIAGRAM OF GENERAL ARRANGEMENTS, MENTANA STREET SUBSTATION, MONTREAL LIGHT, HEAT AND POWER COMPANY.

chamber. A double 2400 volt receiving bus is then provided and connected so that one section or as many distributing feeders may be controlled as may be desired. The remaining feeders may be controlled through the induction regulator as may be desired. The remaining feeders or none at all, if desired, may be operated independently of the regulator. This is accomplished through the use of a double 2400 volt busbar arrangement situated immediately under the distributing switchboard panels.

or shown on the floor plan. It has also an indicating wattmeter. An auxiliary three-phase bus is also provided and intended to work in connection with the above.

In case an overhead 2,400 volt feeder becomes grounded or defective, the one to one transformer is energized through an oil switch, and the defective feeder put on it through the medium of double blade single-throw horizontal disconnecting switches in the basement. Double blade switches are used so that the

circuit need not be opened, but the transformer cut in before the feeder is taken off the main busbars. A wattmeter reading may also be made of any feeder at will, by this combination. The auxiliary panel, as already stated, has an indicating and recording wattmeter mounted upon it.

A panel is provided to control the two 10 panel A.C. series arc switchboard equipments. Iron pipes are laid in the basement floor to carry the 2,400 volt cables, one to each 10 panel equipments.

The house services, all at 110 volts and comprising three 7½ h.p. a.c. blower motors, a two k.w. motor generator set for storage battery charging, induction regulator control motor one h.p., and the house lighting, are all controlled by a special panel and oil switches.

Each panel on this switchboard contains two hand-operating levers for the oil switches in the basement. These are interlocking, and signal lamps are also provided to show which switch is closed and which is open.

crete barriers and covers. These furnish the 110-volt current for above services. A panel with open knife switches and fuses is provided to start up or control any or all of the station services just mentioned.

The motor generator set of two k.w. capacity is used for charging a 55 cell, 20 amp. for 3 hours storage battery.

A special panel is installed with under-load and overload circuit breakers; also ammeter and voltmeter. This panel also controls throw knife switches, the benchboard, oil switch, d.c. bus for opening and closing oil switches.

Attention is drawn to the method of bringing in the 11,000-volt tie-line conductors. These are of 2/0 B.& S. gauge and are eighteen in number. The lines are terminated on a strain insulator of standard make. From there a wire is run through a standard bushing made for this voltage, thence through the station wall and in the building, all the wire being bare.

Fig. 8.—Network of Wrought Iron, Cement Lined Conduit for Control Wires, Mentana Street Substation, Montreal Light, Heat and Power Company.

These oil switches, which are quite heavy, are supported at the back by a heavy bracket bolted onto two 1¼ inch wrought iron pipes, running from end to end through the cell work barriers. This is a decided improvement on the usual method of setting bolts or studs through the centre wall, which as a rule is well occupied with ducts. The pipes may also be lined up more readily than bolts, as formerly used. These switches are automatically tripped by the usual bellows type time limit relay, set to predetermined time limits. The current transformers tripping these relays and controlling the various panel measuring instruments are shown just above the division cell wall in the basement.

A benchboard is provided with hand control switches. From this point all the K switches controlling incoming or outgoing tie lines are opened. This benchboard also opens the H3 oil switches controlling primary and secondary of lowering banks of transformers.

Three 20 k.w. 2,400-volt 110-volt transformers are installed in the basement and carefully isolated by con-

The roof proper is carried out 30 inches horizontally as shown on Fig. 6, and a front, two ends, and bottom are bolted on. These consist of about 1½ inch thick concrete slabs, fairly weatherproof at the joints. This roof extension has some ornamental features and the whole has a pleasing external effect from the street.

The lightning protection on the 2,400-volt feeders and arc circuits consist of the usual single pole lightning arresters and choke coils, all carefully subdivided by soapstone barriers. Double pole arrester units have been found unreliable for this work. The barriers are at least 18 inches deep. Anything less than this has been found unsuitable to confine any arcing.

Tenders for electric wiring and fixtures for the Custom House, Halifax, N. S., have been taken by Fred Gelinas, Secretary of the Department of Public Works, Ottawa.

The Welland County Telephone Company, Limited, has been granted incorporation, with a capital stock of $40,000 and head office at Stevensville, Ont. Among the directors of the company are Messrs. Charles Glenny, John Pierson, Charles E. Saucer and S. H. Tripp.

REPORT OF MUNICIPAL COMMISSION ON NIAGARA POWER

The report of the Ontario Power Commission, appointed by the municipalities of Toronto, London, Brantford, Stratford, Woodstock, Ingersoll and Guelph, to enquire into the question of the development of power at Niagara Falls, has been completed and made public. The Commission was composed of Messrs. E. W. B. Snider, Waterloo, Chairman; P. W. Ellis, Toronto, Vice-Chairman; Hon. Adam Beck, M. P. P., London; W. F. Cockshutt, M. P., Brantford, and Prof. Reginald A. Fessenden, of New York, the technical adviser. Messrs. Ross & Holgate, hydraulic and electrical engineers, of Montreal, were retained in the matter, and a somewhat exhaustive report from them as to the quantity of power required and the cost and returns from such a plant is included in the finding of the Commission. A summary of the report is given herewith.

POWER REQUIREMENTS.

The report summarizes the power requirements as follows:

	H. P.
Total present consumption of the seven municipalities above mentioned	73,631
Total estimated consumption of the seven municipalities two years hence	87,883
Net present consumption of the seven municipalities above mentioned	55,325
Approximate present consumption of eleven additional municipalities as undernoted	25,800

In connection with the above it is to be noted:—

1st. That the estimated increase in power consumption two years hence is limited to the anticipated increased demand of existing consumers. No allowance has been made for additional demands that will arise in connection with inter-urban electric traction development nor for the probable electrification of steam railroads.

2nd. The present net consumption of the seven municipalities directly represented herein covers the quantity of power which—subject to satisfactory prices and existing contracts—an operating commission should, within a reasonable time after the completion of the proposed works, secure supply contracts for. That is to say, that deduction has been made from the gross consumption to cover all power which, because of special local conditions, is regarded as being beyond the reach of municipal competition.

3rd. In carrying out any transmission scheme appropriate to the needs of the seven municipalities represented herein, it becomes possible to furnish power under very advantageous conditions to certain other municipalities, namely: Hamilton, Dundas and Paris, which are in the direct route of transmission; St. Thomas, which is within convenient distance of London; Galt, Hespeler, Preston, Berlin and Waterloo, which are within convenient distance of Guelph; and St. Mary's and Mitchell, which are within convenient distance of Stratford. The operating commission could, because of transmission conditions, deliver to municipal or independent distributing companies in these places the power required by them at very attractive prices, while at the same time such additional deliveries would reduce the cost of power requiried by the seven principal municipalities. The requirements, therefore, of these eleven additional municipalities were approximated at 25,800 horse-power, as given above, hence the net requirements of the seven municipalities directly represented by your Commissioners, plus the approximate requirements of the eleven municipalities aforementioned, amount to 81,125 horse-power. The municipalities included in the subsidiary group are limited to those having a population of 2,000 or over.

Making allowance, however, for the operating commission securing its contracts by degrees, your Commissioners have had estimates prepared of the cost of development capable of supplying 100,000 horse-power, but equipped for the supply of:

(1) 30,000 horse-power, being approximately one-half of the present net requirements of the seven principal municipalities.

(2) 60,000 horse-power, representing approximately the total net requirements of the said seven municipalities, and

(3) 100,000 horse-power, representing the supply of the net requirements of the eighteen municipalities aforementioned with a margin for growth of demand.

CAPITAL COSTS.

The capital costs of the development, transmission and distribution of three amounts of power indicated, including interest and sinking fund for construction period, have been estimated and apportioned between the participating municipalities as follows:

	Cost of 30,000 H.P.	Cost of 60,000 H.P.	Cost of 100,000 H.P.
Toronto	$4,323,096	$6,265,424	$6,216,137
London	847,119	1,095,356	945,185
Brantford	429,152	571,097	509,248
Guelph	317,441	425,386	377,821
Stratford	329,923	431,018	368,154
Woodstock	216,226	278,939	244,589
Ingersoll	221,672	287,391	249,754
Hamilton			1,163,712*
St. Thomas			399,438*
Paris			123,322*
Dundas			66,359*
Mitchell			97,847*
St. Mary's			130,136*
Berlin			426,393*
Waterloo			189,628*
Preston			106,243*
Hespeler			48,095*
Galt			246,939*
Total	$6,684,639	$9,354,611	$11,909,100

*Subject to distribution costs which are according to engineers' specifications.

ANNUAL EXPENSES.

The estimated total annual expenses of all kinds, including water rental, repairs, renewals, contingencies, interest and sinking fund, but excluding taxes for the reason that the undertaking is expressly exempted from taxation, are as follows:

	30,000 H. P.	60,000 H. P.	100,000 H. P.
Interest and sinking fund	$371,163	$519,425	$661,266
All other charges	488,447	619,126	752,368
Total	$859,610	$1,138,551	$1,413,634

It is to be noted that:

1st. Under the instructions of your Commissioners, and for reasons hereinafter stated, interest has been computed at the rate of 4½ per cent. per annum and the sinking fund charge has been computed upon the basis of retiring in forty years the whole bond issue required to pay the original capital cost, but upon the assumption that the investment thereof shall be made at a maximum rate of 4 per cent.

2nd. The above estimate of expenses does not include

anything for distribution in the eleven subsidiary municipalities.

SERVICE RATES.

The rates that it would be necessary to charge consumers in order to make the undertaking self-sustaining on the three developments indicated are as undernoted. These rates are computed on a twenty-four hour basis. The variations of price required to meet the varying duration of service demanded by consumers must be settled by the operating commissioners with regard to the local conditions of demands, etc. These will vary in each municipality, and, as they will remain unknown until the supply contracts are entered into, they cannot be intelligently approximated.

1. MOTOR SERVICE PER H. P. PER ANNUM 24-HOUR SERVICE AT CONSUMERS' PREMISES.

Municipality.	30,000 H.P.	60,000 H.P.	100,000 H.P.
Toronto	$21.97	$15.72	$14.60
London	53.07	23.87	20.34
Brantford	30.02	17.23	15.57
Guelph	27.68	13.36	16.70
Stratford	33.67	21.45	19.42
Woodstock	34.48	21.05	17.52
Ingersoll	33.96	21.61	17.99

2. ARC LIGHTING—COST PER LAMP PER YEAR.

Municipality.	30,000 H.P.	60,000 H.P.	100,000 H.P.
Toronto	$42.02	$37.61	$36.48
London	54.08	44.99	41.36
Brantford	49.73	42.91	40.55
Guelph	47.84	40.69	39.13
Stratford	56.83	47.28	45.20
Woodstock	56.16	48.16	44.64
Ingersoll	72.57	64.08	60.40

3. INCANDESCENT LIGHTING—COST PER K.W.H.

Municipality.	30,000 H.P.	60,000 H.P.	100,000 H.P.
Toronto	$.0741	$.0640	$.0604
London	.115	.0925	.0839
Brantford	.0945	.0778	.0720
Guelph	.0114	.0965	.0926
Stratford	.1218	.0983	.0934
Woodstock	.1307	.1091	.0995
Ingersoll	.1321	.1112	.1023

4. COST PER H.P. PER ANNUM AT MUNICIPAL SWITCHBOARD.

Hamilton	$ 3.89
St. Thomas	13.09
Paris	12.12
Dundas	11.13
Mitchell	24.62
St. Mary's	19.67
Berlin	12.68
Waterloo	14.55
Preston	16.00
Hespeler	28.06
Galt	15.85

PRESENT COSTS OF STEAM POWER AND LIGHTING SERVICES.

The average costs of steam engine power developed for ten-hour day industrial use under the general conditions prevailing in the municipalities your Commissioners represent have been investigated and computed as undernoted. The costs for a twenty-four hour service required in public service plants vary with the peculiar conditions of each undertaking, but they are, of course, much higher than those given below. The arc and incandescent lighting rates are reported by the engineers as varying considerably, but the undernoted scale is submitted by them as a fair approximation.

AVERAGE STEAM POWER COSTS—10 HOUR SERVICE.

	H. P.	
Indicated horse power of plant	10	$111.50
Indicated horse power of plant	25	78.00
Indicated horse power of plant	50	57.50
Indicated horse power of plant	75	53.50
Indicated horse power of plant	100	48.00
Indicated horse power of plant	150	40.60
Indicated horse power of plant	250	32.00
Indicated horse power of plant	500	27.80
Indicated horse power of plant	750	24.00

These prices are based on a 75 per cent. load, which corresponds with average existing conditions.

PRESENT APPROXIMATE LIGHTING RATES.

Municipality.	Incandescent Per K.W. Hour.	Arc Lamp Per Year.
Toronto	$ .08	$69.35
London	.09	83.95
Brantford	.10	55.00
Guelph		65.00
Stratford		65.00
Woodstock	10-15	60.00
Ingersoll		60.00

SAVINGS EFFECTED UNDER A MUNICIPAL DEVELOPMENT.

The savings that would be realized under a municipal development have been carefully estimated. The present net annual demand for power by the seven municipalities your Commissioners represent, which ought, under a municipal development, to be supplied by the operating commission, amounts to 55,325 H.P. This includes arc lighting, incandescent lighting, manufacturing, pumping, traction and other public service requirements. The savings, which represent the difference between existing costs and the costs that would follow a 100,000 H.P. municipal development, are as follows:

Estimated savings on, amount of same, representing a reduction of existing costs of:

Arc light service	$ 78,257	45%
Incandescent light service	92,537	21%
Industrial motive power	769,531	69%
Other motive power	924,233	77%
Annual savings	$1,864,558	63.5%

COST OF POWER AT NIAGARA.

Estimates of the cost of power at Niagara are contained in the detailed report of Messrs. Ross & Holgate. The following table of yearly operating costs and fixed charges are given :

Items.	30,000 H.P.	60,000 H.P.	100,000 H.P.
Wages	$ 17,004	$ 21,684	$ 21,684
General Expenses and Contingencies	17,356	23,816	29,650
Government Rental for Power	32,500	47,500	67,500
Supplies	3,000	4,000	6,000
Maintenance	48,294	74,623	113,427
Interest	108,224	147,189	208,197
Sinking Fund	25,315	34,430	48,701
Total	$251,703	$353,242	$495,159
Cost per H. P. per annum	$ 8 39	$ 5.89	$ 4.95

The above table shows the yearly operating costs of the Niagara development for three developments and includes all fixed charges, operating costs and Government rental for power; the latter on the basis of that already paid by existing companies. Allowance has also been made in general expense item for all contingencies, including compensation for accidents.

It is proposed to transmit from the Falls at 60,000 volts as far as Hamilton on four lines of steel towers, each carrying six bare copper cables. From Hamilton two of these lines, carrying twelve cables in all, would come directly to Toronto. The other two lines would branch off from Hamilton to Brantford. From Brantford a single line of six cables would run to London and St. Thomas, via Woodstock and Ingersoll. Stratford is to be supplied from Woodstock, and Berlin, Waterloo, Galt, Preston and Hespeler from Brantford. A separate line is run from Hamilton to Guelph. The steel towers would be similar to those already erected by the Toronto and Niagara Power Company.

It is understood that the construction of the Hamilton, Lancaster & Brantford Electric Railway will begin this month, the right of way having been secured. The promoter is Mr. Charles D. Haines.

COMMENT ON THE NIAGARA POWER REPORT

The report of the Ontario Municipal Commission on Niagara power, submitted a fortnight ago and published in part in this number, contains some remarkable statements. Its attitude throughout seems to be that of special pleading for municipal owernship rather than a dispassionate setting forth of facts and figures. It appears that it was necessary, in order to make a case, to bring in other municipalties, although the report was in the interests of and paid for by only seven of the number.

That part of the report "forestalling criticism" is a confession of weakness as unexpected as it is complete. To say that no one "interested" in electrical matters is worthy of belief except the members of the Commission, who apparently are "interested" in municipal ownership, is a position that should not be taken by men who have confidence in themselves and the reliability of their own findings.

The amount of power estimated is greatly in excess of actual requirements and no account is taken of the fact that the present companies, with their enormous equipments, are not going to step out and leave the field entirely to the municipalties. Contracts have been made for the greater part of the output and the fact that the present companies must remain in the field would still further reduce the amount and therefore increase the price of the municipal transmission.

No account appears to have been taken of the fact that nearly all power consumers make use of intermittent power. In the price given for light, which is practically the same as now obtains in Toronto, namely, 7½ cents per kilowatt, account is taken of this intermittent use, hence the higher price.

The majority of power users are intermittent users and therefore the figures given for power are totally inadequate.

It seems strange that business men—men who scrutinize closely the various items affecting the cost of carrying on their own business—should be willing to father a report of this kind without, apparently, giving the subject due consideration and investigation. In selling the power the Commission have fixed on a flat rate of $21.97 per horse power for Toronto customers, which means that a person taking,say, one horse power and using it for an hour each day would be compelled to pay the same price per horse power as the customer who would use the power for the full twenty-four hours. On the basis of cost given by the Commissioners, a customer in Toronto using 50 horse power would be required to pay approximately $1100 per year. This, we believe, is much greater than the average now paid for 50 horse power, as there are several customers in Toronto the aggregate of whose motors reach 50 horse power, but who pay considerably less than $1,000 per year for this power, and it is not unlikely that similar conditions exist elsewhere. Business men, therefore, should consider the conditions very carefully before committing themselves in favor of the project of the Commission.

As no detail of construction or operating expenses is furnished, it is impossible to say without going into details of these items whether they are correct or not, but in the light of the experience of other companies, they appear to be low. The loss on transmission is placed at 10 per cent. No one in the least conversant with actual operation of transmission lines would place this at less than 20 per cent.

Overhead wires are figured on. Three substations, for instance, are laid out for Toronto, to which 10,000 volt wires would have to be carried through the streets from the terminal station of the 60,000 volt line. It is needless to say that this would not be tolerated and stamps the report of the Commission as either wanting in engineering experience or purposely confusing the issue in favor of municipal owernership.

The Commission has made no attempt to investigate the prospective market for power or how many present steam users would change to electricity at the prices quoted. Many factories which are now using steam power require live steam in their manufacturing processes and all during the winter months require boilers to be kept in operation for heating. Others, such as wood-working establishments, box-makers, tanners, shoe factories, etc., make use of refuse products of their factories as fuel and could not afford to change to electric at the prices given. No account seems to have been taken of these.

A lump amount of 60,000 horse power is taken and it is assumed that this will be used full time and the costs are figured on this amount. Why limit the amount to 60,000 horse power? The figures would have been still lower if the amount were fixed at 100,000 or 200,000 horse power. The amount would be immaterial so long as the actual requirements of the market are so greatly exceeded in the estimate.

Although the report of the Hydro-Electric Commission has not yet been published, Mr. Cecil B. Smith, the engineer in charge, has stated in an article by him in the Queens' Quarterly Magazine for December, 1905, page 131: "Niagara power will dominate an area in Ontario roughly bounded by Toronto, Guelph, Waterloo, Stratford, St. Mary's, London, St. Thomas and Simcoe. Beyond this it is not probable that it can successfully compete with power generated in an economical manner from cheap coal, oil or gas."

It will be seen that at Toronto, the cost of Niagara power and power produced by coal, oil or gas will be about equal, Toronto bieng fixed as the limit of probable distribution.

It must be said in favor of the representatives of the municipalties interested in the report, that upon its presentation it was at once seen that the production and transmission of electric power was hopeless as a municipal enterprise and that unless the Government could be stampeded into assuming the burden that they were unwilling to shoulder themselves, the companies already engaged in the enterprise must be allowed to work out the problem on the lines already determined on. The enormous cost of the undertaking and the slight difference in the cost of power and light apparently settled this matter beyond peradventure.

If the municipalties cannot do it successfully, the Government could do it still less, as they would have to include many places where power would be supplied at a loss for manifest political reasons.

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Correspondence is invited upon all topics coming legitimately within the scope of this journal.

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Efficient Illumination. In considering improvements for increasing the efficiency of our various methods of illumination, we are confronted by one undeniable fact, namely, that so far as the generators, distributing wires and transformers are concerned, very little can be hoped for from this class of apparatus. In modern generators, of large or even medium capacity, we can obtain a commercial efficiency of ninety-five per cent. The use of high voltages has made our wiring loss practically negligible, and transformers are now built in sizes commercially adapted for street service, with an efficiency of ninety-nine per cent., and even higher. Therefore, if we exclude the question of efficiency of the prime movers, it naturally limits our field of investigation to the lamps themselves, and it is in this department that most progress has been made during the past few years. Improvement has certainly been made in the prime mover, and while installations of new types of engines are being made all over the country, we hardly feel that we are yet in a position to adopt these new classes of apparatus, and universally discard the old steam engines. Steam boilers are today fairly efficient, for in a plant using the best types of apparatus, including economizers and superheaters, it is possible in some cases to deliver in the steam eighty per cent. of the heat energy of the coal. A loss is necessarily entailed in conveying the steam from the boiler to the engine, though if pipes are properly installed and are covered with an approved insulating material, this loss can be made comparatively small. It is in the engine itself that the serious loss occurs, for even in the best types of triple expansion, Corliss valve engines, the highest point yet reached shows that the machines are capable of extracting from the steam but eighteen per cent. of the energy which is contained therein. In figuring the combined efficiency, we find that a little over fourteen per cent. is the best which can be obtained, even under the most favorable conditions. The introduction of the gas and gasoline engine marked a very material advancement in the science of economic prime movers. The producer gas equipment goes a step further, and gives an efficiency with which no steam engine can compete. The internal combustion engine, which successfully uses crude petroleum, gives, undoubtedly, the highest efficiency which has been recorded to date. A thermal efficiency of thirty-five per cent., obtainable in even small sizes, makes a very favorable showing when compared with a combined efficiency of fourteen per cent., given only by steam equipments comprising very large units. Crude petroleum engines have as yet several inherent weaknesses, but with the present rate of scientific progress, it can be reasonably expected that such weaknesses will be eliminated in the near future. So much for the prime mover question.

In the incandescent lamp the use of a tantalum filament has certainly shown that carbon is not the ideal material, so far as efficiency is concerned, but with tantalum we also have several inherent defects which must be overcome before the lamp can be made a commercial article. In the mercury vapor lamp a much higher efficiency has been obtained, but the light has several peculiarities which renders it unfit for general use, though we must acknowledge that for

some purposes it has proved itself to be ideal. So far as this lamp is concerned, it can at present compete with the enclosed arc, which for many years has been looked upon as our most efficient method of illumination. Of course, the enclosed arc has much in its favor, for the quality of its light has been favorably compared with the radiations of the sun. The improvements in arcs undoubtedly attract more attention today than any of the changes effected in other types of lamps, the "luminous arc" type, two of which are on the market, giving rise to most comment. These lamps have been mis-named as "flaming arcs," and while this may be to a certain extent descriptive of the arc itself, the term "luminous arc" should be adopted, as it exactly fits the prime feature. In the old open and closed types of lamps, the much greater portion of the light comes from a spot about the size of a pin's head on the positive carbon, named the "crater." In the open type lamp, operated on direct current, this feature naturally has a material effect upon the distribution, almost all the light being thrown downward, and very little being distributed on a horizontal plane, where, as a matter of fact, it is most needed. The enclosed arc has, to a certain extent, the same weakness, though the crater in such a lamp, not being confined in a pocket, is in a much better position to distribute the light horizontally. This accounts, in a very simple way, for the superior distributing powers claimed for the enclosed arc. The lamp is not, and probably never will be, as efficient as the old open type arc, but although its efficiency is less, the fact that carbons burn square, and allow more light to be thrown horizontally, makes the lamp a much better article so far as illumination is concerned.

The principle of all luminous arcs, which term naturally implies that the chief source of light is the arc itself, and not the crater, lies in the fact that certain chemicals, heretofore unused, are introduced into or as the electrodes. There are two classes of such lamps, one of which is of American origin, the other having been brought out in Germany. The general mechanism of the American lamp is very similar to that of the standard enclosed arc, though of course modifications have been made in the control to suit several new conditions which have been created. For instance, the upper or positive electrode is made of copper, and is not movable in the ordinary sense of the word, that is to say, it does not feed. The lower electrode is a stick of magnetite (black oxide of iron), a mineral found in great abundance throughout the iron producing States. This lower electrode is controlled by the lamp mechanism, and hence the lamp feeds upward, and not downward as in the standard types. This magnetite stick being the negative, is consumed very slowly, giving a life of about 175 hours for each trim. The positive copper electrode has a life of a few months, and the cost of replacing is comparatively small. As a matter of fact, the cost of trimming in the magnetite arc exceeds that of the standard enclosed arc, but is not as great as the cost of trimming for the old style open arcs. The copper electrode is in shape a sector, and swings from a pivot in such a way as to neither increase nor decrease the length of the arc. This electrode has two surfaces, called the striking surface and the burning surface, respectively. When the arc is extinguished, the striking surface is presented over the magnetite stick, and when the lamp is thrown into circuit the magnetite hits against this striking surface and is drawn away, establishing the arc. The copper electrode immediately changes its position, so that the arc exists between the magnetite and the burning surface. This arrangement is required because a chemical deposit is made upon the burning surface, which might be sufficient at times to prevent the striking of the arc. With the scheme above mentioned the striking surface is always clean, and the swinging of the copper electrode produces a wiping effect upon the burning surface, which tends to a great extent to remove the chemical deposit. The arc is maintained at a length of about seven-eighths of an inch, and is, as before stated, the principal source of light. This lamp so far has been designed for series direct current circuits only, nothing having been done to adopt it for alternating currents, or for interior multiple connections. Whether the lamp will ever be available for inside lighting is a question, for there is a chemical dust given off when in operation, and as the lamps are now constructed, a chimney is built up through the centre of the mechanism to carry this dust off to the open air. The lamp, operating on four amperes, gives practically the same amount of light as the 6.6 ampere direct current enclosed lamp, but the horizontal distribution is very much better in the former than in the latter. Thus the lamp is extremely desirable for street lighting work, considering the distribution only, and gives an additional advantage of the same amount of light for a considerably lower current consumption. The magnetite arc is an open arc lamp in every sense of the word, the long life being due to the materials used as electrodes, and not to the exclusion of air, to which the long life of the standard enclosed arc is due.

The other type of lamp, known as "The Siemens Flaming Arc", is also of the open type, but has a life of but ten to fifteen hours. The arc, however, must be protected from drafts of air, and therefore the globe is, to a certain extent, more closed than that required by the magnetite lamp. The electrodes are not one above the other as in our standard types, but are both fed from the top, coming together at an angle. To prevent the arc from mounting the electrodes, a small magnet is placed between their tips, which tends not only to keep the arc from mounting, but in fact causes it to bulge down into the globe. The actual length of such an arc may be anywhere from one and one-half to two and one-half inches. Such lamps of this type as have been seen in this country and the United States are noticeable through the distinctive golden yellow color of the light and the intense brilliancy. We understand, however, that by means of various chemicals, which can be incorporated into the electrodes, that either a red or a pure white light can be obtained. Not much data is available at the present time on the actual efficiency of this type of lamp, beyond the general statement that for the same current consumption it produces from four to five times the amount of light given by an enclosed arc. The lamps are made for direct current, and alternating current where the frequency of the latter circuit is sixty cycles or above. One great advantage is that the arc voltage does not exceed forty-five, and therefore the operation of two in series on one hundred and ten volt mains is entirely satisfactory.

PRODUCER GAS PLANTS.

By Lionel S. Marks, S.B., M.M.E.

Producer plants are of two kinds, according as the flow of air through the producer is caused by air being forced in from below or a partial vacuum being created above the fuel. The former is called a *pressure plant*, the latter a *suction plant*.

PRESSURE TYPE.

The general arrangement of the pressure type of producer gas plant is shown in Fig. 1, in which the arrows indicate the direction of flow of the gas. A small boiler supplies steam to the "blower." The gas escapes from the producer at a high temperature and goes to an "economizer," where it gives up much of its heat, either to fresh air, which is about to be forced through the producer, or else to water, the vapor from

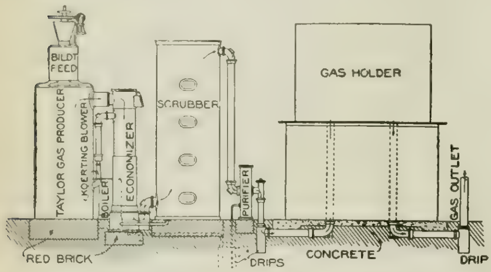


Fig. 1. Diagram of Pressure-Type Producer Plant.

which mixes with the air. The gas then passes to the "scrubber," where it meets a spray of cold water, which further cools it and takes from it dust and solid impurities, after which it goes to the "purifier," for the extraction by chemical process of certain undesirable components and for the completion of the removal of solids, and thence to the "gas holder." If anthracite coal or coke is used, very little chemical purification is necessary; if bituminous coal is being burned, the cleaning is somewhat more complicated, as the tar and other troublesome substances in the gas have to be extracted before it can be used.

SUCTION TYPE.

The suction type of gas producer plant can be used only when the operation of the engine is continuous for long periods. It has considerable advantage over the pressure type in compactness, but is rather troublesome to start. The flow of air and vapor through the fuel in the producer or generator (Fig. 2) is dependent on the sucking action of the engine each time it takes in a charge, so that no boiler is needed to produce the blast. The volume of gas generated is always equal to the amount that the engine uses, so that no gas holder is required between the producer and the engine, its place being taken by a small gas tank. To start the producer working, a small hand or belt-driven blower is used; and the products of combustion are sent past a by-pass valve directly to the atmosphere until the escaping gas will burn steadily. The by-pass valve is then closed, and the gas is forced through the scrubber and purifier into the gas tank, and the whole apparatus is filled with gas. When good gas appears at a test cock near the engine, the engine is put in operation and the blower is stopped, its function being performed thereafter by the engine. The hot gases escaping from the generator go first through an economizer or vaporizer (not shown in Fig. 2); and the steam formed there is conducted to the under side of the grate of the producer, and is sucked through with the air.

Owing to the resistance offered by the fuel, scrubber and other parts of the plant to the passage of the gas, its pressure on reaching the engine is considerably below the atmospheric pressure. This causes a decrease in the weight of the charge taken to the engine, and so makes the power of the engine less than when pressure gas is used. In order to get the high compression which is necessary to ensure ignition with a weak gas supplied at low pressure, the clearance in the engine using suction gas is smaller than in other engines using the same cycle. It is not safe to use such an engine with illuminating gas, as the pressures resulting from explosion would be excessive. When in some cases illuminating gas is used to start the engine, a special device is employed to exhaust some of the charge during the compression period, and so to reduce the compression pressure.

HEAT WASTE.

An efficient producer of either the pressure or suction type will waste not more than fifteen to twenty per cent. of the heat of combustion of the coal in converting it into gas—that is, the gas, on burning, will give up eighty to eighty-five per cent. of the heat of combustion of the coal. Its efficiency exceeds that of a steam boiler. If the gas produced is a weak one, it is produced in greater volume, and it has to be mixed with a much smaller volume of air than is required for illuminating gas. For example, ordinary coal gas must have at least six parts of air to one of gas, whereas producer gas requires a minimum of about one and a-quarter parts of air to one of gas.

The heat liberated by the combustion of a cubic foot of each of the gases discussed is as follows:

Natural gas	900-1,000	B.T.U.
Coal gas	650- 700	"
Water gas	- 300	"
Producer gas	120- 150	"

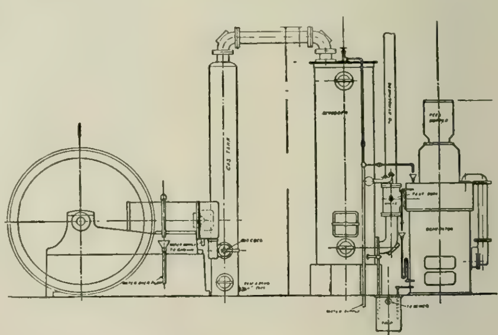


Fig. 2.—Diagram of Suction-Type Producer Plant.

POWER PRODUCTION.

The power which can be developed in an engine does not depend upon the heat of combustion of a cubic foot of the fuel, but on the heat of combustion of a cubic foot of the explosive mixture. The difference in the amounts of air necessary for combustion with the different gases makes the heats of combustion per cubic foot of the explosive mixture much more nearly equal than the heats of combustion per cubic foot of the fuel. Thus, when mixed with just sufficient air for complete combustion, natural gas, coal gas, and water

gas will give up about 90 B.T.U. per cubic foot of the explosive mixture, while producer gas gives up about 65 B. T. U. An engine will consequently develop about the same power whether using natural gas, coal gas, or water gas ; when using producer gas, on the other hand, it will develop considerably less power.

MARITIME ELECTRICAL ASSSOCIATION.

Further particulars have reached us of the meeting of the Halifax members of the Maritime Electrical Association held in Dalhousie College on the evening of March 8th. Mr. C. W. McKee presided, and there were twenty-five members present. After some discussion it was unanimously decided to form a local organization to meet monthly during at least nine months in the year. A committee was appointed to draft a constitution and nominate officers for the next meeting. Mr. F. H. Sexton, Professor of Mining Engineering of Dalhousie College, was then introduced by the chairman and delivered a lecture on "Electrical and Industrial Development at Niagara Falls." The lecture was illustrated by lantern slides and was most interesting and instructive throughout. At its close the lecturer was tendered a hearty vote of thanks.

EXHAUST STEAM FOR HEATING.

Exhaust steam from the municipal power house is utilized at St. Thomas, Ont., for heating the civic buildings, Mr. James A. Bell, City Engineer, being responsible for the introduction of the system. Writing to the ELECTRICAL NEWS Mr. Bell says:

"The City of St. Thomas owns and operates the electric street railway, the electric lighting plant and the gas plant. The power house for operating the electric railway and electric plant is situated about 700 feet from the city buildings and is in connection with the gas plant. On taking over the electric light and street railway, I found that there was a large amount of loss in the way of exhaust steam. I made a proposal to the Council to use this in heating the buildings, the city hall, free library, and the large gas house and storage battery room. The city hall and free library had been fitted up for hot water heating. I had installed in the power house a heating boiler of a capacity sufficient to heat the buildings. This boiler is what is called the Wainright boiler and is filled with corrugated copper tubes, the steam passing through it, and in this way heating the water in the tubes to the same heat as the exhaust steam. The water thus heated is forced through piping to the different buildings and it simply makes a circuit. The way we regulate the amount of heat in the buildings is to speed up the pump. By taking thermometer readings on the outside, we are enabled to regulate the speed of the pump in accordance with the outside temperature.

"The estimated cost of heating those buildings formerly was about $1,200 per year, and at the present time it is done by what was before that time a waste product. It has worked very satisfactorily. The only inconvenience caused at times is that there is too much heat instead of too little. The pipes are laid under ground and wrapped so as to prevent radiation, and enclosed in a tile which is made water tight."

C. E. A. QUESTION BOX.

Mr. A. A. Dion, Editor of the Question Box of the Canadian Electrical Association, is now receiving questions for the 1906 Edition, and will shortly send out circulars calling for answers.

The duty of every member of the Association is to assist the Editor of the Question Box as much as possible—first, by sending in questions, and secondly, by answering at least some of the questions submitted.

Have YOU done your duty in this respect? If not, there is still an opportunity to make amends by prompt action.

The Question Box must be published early in June, and intending contributors should send in their questions immediately so that they may be included in the first list, which will be mailed to members this month.

The Editor deserves and expects your support and co-operation.

IRON CONDUIT.

MONTREAL, April 6th, 1906.

Editor CANADIAN ELECTRICAL NEWS:

Dear Sir,—Referring to the remarks of "Reader" in your last issue, I desire to add my quota 'contra' to same. The last point in "Reader's" remarks being presumably of least interest to your readers, can be dismissed first in a few words. The best is not always the cheapest; but, even admitting, it logically follows that if he can underbid in conduit the same procedure can apply to "skeleton-concealed" and other forms of wiring. The main point at issue is not that conduit is used all over the world, and not to condemn the use of conduit in its proper sphere, but is there not too much thought of it? I speak locally.

The Underwriters naturally reason that wires in iron pipe are not liable to cause fire; but if they are perfectly sure, why not rebate insurance premiums where such is used in residences of ordinary construction.

Now, whilst admitting its use in large office buildings and the like of fireproof construction (where the use of iron pipe is practically compulsory), where does it come in for the usual type of residence? The Underwriters themselves are not booming it for such work, and yet architects have gone mad on iron pipe, often putting a ground floor in conduit, whilst the balance of the house is skeleton-concealed. As many house owners are not sure of their locations when the house is being built, they are thus presented with an exceedingly "non-flexible" system, expensive to alter, and of really no greater fire security than properly installed skeleton-concealed wiring.

"A chain is no stronger than its weakest link," and one electrical engineer remarked to the writer that in his opinion when a branch circuit was run off in moulding from a conduit installation, the whole should be then classed as a moulding job, and the bulk of alterations or later additions in such cases are generally so made.

The representative of a prominent electrical house in Boston (the mention of this city should conjure feelings of respect in "Reader's" breast) stated that he heard the Underwriters in the United States were not by any means a unit on the question of shoving iron conduit among beams, lath, etc. Locally we have aerial construction, and such a thing as 2,000 volts coming into a residence has (though rare) been known.

I have already taken up too much of your space and must draw these remarks to a close by stating that the writer was present at the meeting before referred to, and no defence was made except by one party to the remarks made by the able engineer, (whom I am not attempting to defend, as he is quite capable of defending himself.)

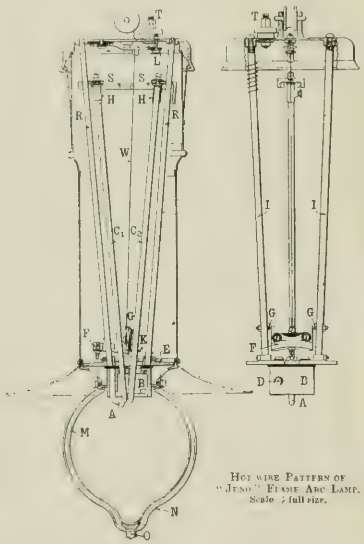
Yours truly

WM. B. SHAW.

The Alphaduct Manufacturing Company, Limited, has been granted incorporation by the Ontario Legislature with head office at Toronto, Ont., to carry on the business of manufacturing and dealing in electric conduits and all kinds of electrical supplies. The capital of the company is $40,000 and its directors are Messrs. F. B. Johnston, C. W. Bongard and S. Johnston.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

"Juno" Flame Arc Lamp.—The "Juno" flame arc lamp has recently been placed on the market by Johnson & Phillips, of Old Charlton, England. At present it is made in one standard size, which is stated to emit about 2,300 c.p. (mean spherical) at a consumption of 450 watts. Referring to Fig. 1, C_1 and C_2 represent the carbons, which are of a special quality, and not of the metal core variety. When the lamp is to be fed by continuous current, the carbons are of different thickness, and in the lamp we were shown at the works, the carbons were of a diameter of 8 mm. and 9 mm. respectively. If fitted with these carbons, the lamp,



Hot wire Pattern of "Juno" Flame Arc Lamp. Scale ¼ full size.

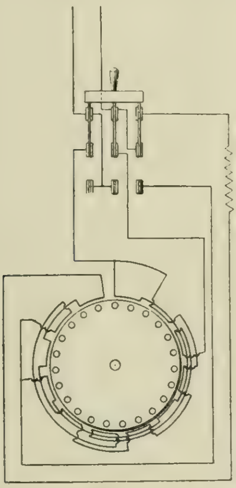
which consumes from 8 to 10 amperes, will burn from 10 to 12 hours before needing re-trimming, but with carbons of 11 mm. and 13 mm. the hours of burning are increased to about 20. When used on an alternating-current circuit, carbons of the same thickness are used, of course. The carbons are 18 in. long, and are clamped at the top by the carbon holders HH, which are fixed to, but insulated from, the cross slides SS. By this arrangement, if the carbon C_1 is allowed to drop, C_2 will travel down at the same rate. RR are of brass rod, and serve to guide the cross slide. The carbons converge towards their lower ends as shown, and pass through two holes in the brass cup B. The carbons slide down together by gravity until the carbon C_1 rests against the abutment A, which is simply a bent copper bar secured by the screw D to the metal cup B. This cup, which is split to allow for expansion, is fastened to, but insulated from, the brass plate E. Its chief function is to protect the flame arc from draughts, but it also helps to reflect the light downwards. The copper piece A is provided for the carbon C_1 only, and the cross slides, the guiding rods and the holes in the cup B ensure that the second carbon C_2 moves in exact step with C_1. The magnetic flux to elongate the arc is created in the iron rods II, which are wound with bare copper wire. This wire is insulated from the iron rod by a layer of mica and other insulators. W is a stout wire of a nickel-iron alloy, which also contains a little copper. When the lamp is not burning, the tension of the wire W keeps the striker F (whose fulcrum is at G) in the position shown, and the carbon C_2 is pressed against the carbon C_1 by the collar K, which is rigidly fixed to the striker. L is a thumb-screw, by means of which the tension of the hot wire W can be adjusted. In order to assist cooling, the middle portion of the hot wire is flattened out.

If the lamp now be switched into circuit, current will enter by one of the terminals TT, and, after flowing through the hot wire, the carbons and the blow magnets in series, will leave by the other terminal. The flexible connections (not shown in drawing) between the various parts are protected in the customary manner by insulating beads. The hot wire heats up very quickly and elongates, and the striker is free to rotate in a counter-clockwise direction about G by gravity. At the same time the collar K moves towards the right, and in doing so draws the carbon C_2 away from C_1. In this way the arc is struck. When the current is switched off, the hot wire cools down and contracts; the striker is rotated in a clockwise direction against gravity and the carbons are again brought into contact with one another, ready for starting the arc.

Bituminous Gas Producer.—Many attempts have been made to construct a gas producer which will use bituminous fuel, and make a gas of high quality, free from tar. It is stated that the object has been achieved in the Simplex producer, lately brought out by the Industrial Engineering Company of Hyde, England. Some producers have used bituminous fuel, but the gas made in them has been of low quality, varying in calorific value from 100 to 150 B.t.u.; the gas being charged with tar when it issues from the producer. Manufacturers of these producers claim to be able to eliminate this tar, by the use of various devices, but, in some cases at least, the tar gets past the extractors, when the engine is quickly brought to a stand-still. No tar-extracting appliances are required in the Simplex plant, the tar in the coal being converted into a permanent gas before it leaves the generator, and it is claimed that the gas produced can be used for any purpose to which town gas is applied. These producers are made in sizes from 20 horsepower upward. In the larger sizes, the generator portions are made up of several units. The plant consists of a generator fan, motor, washer and gas holder. No boiler, high-pressure steam or storage gas holder is required, the small vessel used being of sufficient size to maintain a steady flow of gas at uniform pressure. Assuming that ordinary slack can be obtained for $1.90 a ton, or sundried peat at $1 a ton, the fuel cost of the gas would be less than 4 cents per thousand cubic feet in a

plant of 100 horsepower. This would be increased to 7 cents a thousand feet if allowances were made to cover labor, interest and depreciation of the plant. Taking the cost of the gas produced at 7 cents per thousand cubic feet, it is equivalent to buying town gas at 14 cents a thousand feet, so that the saving in cost can easily be ascertained by comparison with the price at present paid for town gas. In ordinary installations, up to say 100 horsepower, it is stated that the cost of working gas will be about one-sixth to one-fourth that of running with steam.

Single-Phase Induction Motor.—As is well known, at or near half speed a single-phase induction motor has considerable torque. The accompanying illustration shows a scheme proposed by Mr. B. G. Lamme for bringing the rotor up to half speed in order that the machine may then be switched to the simple single-phase connection. The main primary winding is divided into two groups of coils, which are connected in series in starting the motor and in parallel for running, the current being reversed in one portion of the winding. The number of the poles induced in the



SINGLE-PHASE INDUCTION MOTOR.

primary member with the two portions of the windings in series is double the number corresponding to parallel connection of the two portions of the windings. The number of the poles produced by the current in the auxiliary winding is equal to the number of poles due to the current in the main winding when its two portions are connected in series. The usual "phase-splitting" resistance is connected in the auxiliary starting circuit.

New Water Wheel Governor.—The National Water Wheel Governor Company, Akron, Ohio, have placed on the market a new type of water-wheel governor entirely eliminating pawls, ratchets, trips or slides in its construction. The manufacturers claim that the governor is peculiarly fitted for the exacting requirements of water-wheel governing. A double-ended cone clutch and two outer friction cones are mounted on the pulley shaft. One of these outer cones is keyed to the shaft and drives the other outer cone in a reverse direction by means of an idler gear. The gate movement is thus effected by pressing the cone against one or the other (as the case may be) of the outer clutches. The double-ended cone is spur-geared to the master gear, through which is passed the gate-moving shaft. Attachment can be made at either end of this shaft to the gate shafting. The driving pulley can rotate in either direction and can be placed on either end of its shaft. A powerful electromagnet or solenoid plunger is attached to a fulcrumed lever, and this lever presses the cone clutch one way or the other to effect the movement of the gate. The governor is thus electricall tripped, giving practically an instantaneous response, as the outer clutches are in constant rotation. A quick acting spring governor head operates a small lever, and this lever closes the circuit one way or the other, as the case may be.

All-Steel Insulator Pin.—Frank MacKean, of Chicago, has invented an all-steel insulator pin which he believes will do away with the annoying wood ends, segments and other devices that have heretofore been the adjuncts of metal pins other than the heavy, rigid cast and malleable ones. It is believed by many that the era of the wooden pin is fast passing away, locust becoming each year higher priced and more difficult to obtain, while other woods are not so suitable for this work. The unique feature of the construction of the MacKean all-steel pin is that it is composed of one strip of metal sheet, which is stamped into a pin with perfectly formed threads, a base and a rounded stem, so shaped as to make it amply strong to carry the strains of the heaviest line work. Ready adaptation to all the different forms of brackets, as well as to the numerous styles of special pins that have come into general use with the advent of high-tension transmission, will, Mr. MacKean believes, quickly make it a general favorite with the construction man, whether he be building a rural telephone line, a village lighting system or a 40,000-volt power-transmission line.

Direct Current Railway in Bohemia.—An interesting direct-current electric railway which possesses some features which are radically different from American practice has recently been installed between Tabor and Bechin, in Bohemia, by the well-known electrical establishment of F. Krizik of Prag-Karolinenthal. The line is 24.24 kilometers in length and has five stations. The system makes use of direct-current generated at 1,400 volts and distributed on the three-wire system, with the rails for the neutral, and 700 volts between them and each of the two overhead conductors. This system of operation has been suggested, but has never met with favor. Mr. Frank J. Sprague, however, believes that the working voltage of direct-current railways may be as high as 1,500 volts or more, with attendant advantages. In the Bohemian railway under consideration we are able to discern a tendency in this direction. Of course in this case only 700-volt motors are used, which are connected in parallel between the neutral and the two outside conductors, or in series between the outside conductors, but still 700 volts is a distinct rise in motor voltage over the 500 or 550 volts now customary in direct-current railway practice.

Western Canada

ELECTRIC LIGHTING AT EDMONTON.

Edmonton, Alberta, has recently completed a new series arc lighting system, which extends to all parts of the city. This replaces the system of multiple arc lamps which had been in use formerly, on the main streets only. The Canadian Westinghouse Company furnished the regulators and lamps, which are their latest improved type. At the present time 53 arc lamps are in use throughout the city, and plans have passed the City Council for the installation of fourteen additional arcs for outlying points.

A motor valve for the regulation of the supply of water from the reservoir tank has also been installed.

SHOWROOMS AND WAREHOUSE OF THE CANADIAN GENERAL ELECTRIC COMPANY, 148 NOTRE DAME STREET EAST, WINNIPEG.

This is automatically operated from the electric light and pumping station.

The City commenced supplying day power on November last, and since then there has been a great demand for power for elevators, and manufacturing purposes, the power being exceptionally cheap owing to the low cost of fuel.

Electric signs are also becoming quite fashionable in Edmonton, and judging by the way orders for them are coming in the main thoroughfares will soon be a blaze of light at night-time.

WESTERN SPARKS.

Electrical workers in Vancouver, B.C., have asked for an increase from $3 to $3.25 and an 8 hour day.

The Bell Telephone Company are installing a local system at Shoal Lake, Man., and Mr. T.W. Miller has been appointed local agent.

It was recently announced by Mr. R.H. Sperling, general manager of the British Columbia Electric Railway Company, that an electric lighting service would be installed in Ladner, B.C., by October 1st.

Mr. G.C. Hinton, of the Hinton Electric Company, of Victoria, B.C., has a proposition to supply electric light and power for Enderby. He proposes that the corporation should install the plant and procure the power from the Kamloops Lumber Company, who will take 40 per cent. of the receipts thereof for so doing.

At a meeting of the Electrical Contractors' Association of Winnipeg held on April 2nd, the following officers were elected: President, Mr. T.D. Hudson; vice-president, Mr. H. H. Ross; secretary, Mr. Charles F. Mitchell.

At a public meeting recently held at Carnduff, Sask., it was decided to organize a telephone company with a capital of $10,000. The following were elected as provisional directors: Messrs. W.T. Lockhart, Foulds, Gordon, Taylor, Preston, and Elliott. It is proposed to install a first class plant at as early a date as possible.

The British Columbia Telephone Company have awarded the contract for the construction of a new fireproof central exchange on Seymour street, Vancouver, to Messrs. Baynes & Horie. The building will be a three-storey structure of brick and stone having a frontage of 45 feet. It will be made as fireproof as possible. The estimated cost is $45,000.

Word comes from Vancouver, B. C., that work has been commenced on the proposed power plant for the Stave Lake Power Company. Col. Tracey and Mr. George C. Hinton, who have charge of the work, expect that the hydraulic plant will be completed this year. The dam and head works will be of stone and concrete and will be of very permanent construction.

The Burrard Power Company have been granted a record of 25,000 inches of water from the Lillooet river and lake by the Water Commissioners of New Westminster, B.C. They purpose developing this water power for generating electricity. They will install a plant capable of generating 5,000 horse power at first and increasing it to 20,000 h p. as the demand grows. The power house of the company will probably be located at tide water on the Fraser river near Port Haney. The estimated cost of this work is $500,000.

General A. L. New, vice-president of the Pacific Wireless Telegraph Company of Los Angeles, Cal., recently visited Victoria B.C., in connection with maturing plans for important developments in the company's business along the northwest Pacific coast. He stated that important improvements and extensive works had been decided upon in connection with the Victoria station at Ross Bay. Othe developments of the British Columbia field are being considered, of which he hoped to make more definite announcements later.

The 250 horse-power electric hoist which was built for the Granby Smelter at Phoenix, B.C., by the Jenckes Machine Company, Limited, of Sherbrooke, Que., was shipped recently. The fact that this hoist has been built by a Canadian firm is noteworthy. The hoist has two conical drums, each 8½ feet diameter at large end, 5 feet diameter at small end and 5½ feet long, both drums being capable of independent operation through the medium of powerful friction clutches. The capacity of the hoist is a load of 10,000 pounds on either drum at 500 feet per minute, and the shipping weight in the vicinity of 50,000 pounds.

Messrs. Simpson & Lewis, engineers, Ottawa, will superintend the erection of the new power house and dam at Parry Sound, Ont.

The Toronto branch of the American Institute of Electrical Engineers, organized May 28th, 1903, have issued a neat booklet containing a list of the members.

The Westinghouse Machine Company are furnishing a 3,000 k.w. steam turbine for the Grand Trunk Railway for use in connection with the electrical equipment of the Sarnia Tunnel.

As the Street Railway Company of St. John, N.B., intend doing away with the Carleton electric light station and serving their patrons direct from the city, a cable is being stretched along Douglas avenue to carry out their plans.

The Westinghouse Machine Company have begun a third suit against the Allis-Chalmers Company, in which infringement of another Westinghouse-Parsons steam turbine patent is alleged. The bill was filed in the Circuit Court for the District of New Jersey, and the the Westinghouse Company charge the Allis-Chalmers Company with infringement of patent No. 788,830, owned by the Westinghouse Machine Company. This patent covers the construction of the rotating element of the turbine as used by the Westinghouse Machine Company and the Allis-Chalmers Company. The suit was filed on Wednesday, April 11th.

MONTREAL

Branch Office of Canadian Electrical News,
38 Alliance Building, Montreal.

April 9th, 1906.

Considerable sympathy will be felt for Messrs. Leonard and McQuaid, who composed the Electric Engineering Company on Inspector Street and who have lately gone into voluntary liquidation. It is only one more proof that the wiring contracting business is rushed to death in the city of Montreal, and even a man of ability cannot always keep on his feet.

The directors Westmount municipal plant claim to have taken 87 residential contracts for incandescent lighting to date. They also state that so as to accommodate customers from the 1st of May, which is the date when all removals take place in Montreal, they hope to have a temporary plant in operation to take care of new customers. It is a fact, nevertheless, that the Montreal Light, Heat & Power Company have booked many five-year contracts in that district.

A few of the new Siemens flame arcs are in evidence in Montreal. These burn two in series on 110 volt and consume a pair of carbons in 10 hours. As the cost of each lamp is approximately $50, and the cost per trim of carbons approximately 12 cents, it would look as if the high first cost of carbons and frequent trimming would offset the advantages received in the shape of a more powerful and yellow-colored light.

Mr. Willson, of Messrs. McDonald & Willson, Toronto, paid a visit to their Montreal house recently. Mr. Willson has been in Florida lately on account of his health and seems to have regained something of his old strength.

COMPLIMENTARY DINNER.

A complimentary dinner was given to Mr. W. F. Dean and Mr. F. John Bell by the office and warehouse staff of the Canadian General Electric Company, Montreal, at the Windsor Hotel on Monday evening, April 2nd, on the occasion of the severing of their connection with the company. Mr. Dean goes to New Haven, Conn., while Mr. Bell has joined the sales organization of Allis-Chalmers-Bullock, Limited.

Those present at the dinner, in addition to the guests of honor, were Messrs. W. P. Roper, W. H. Reynolds, Gordon Hulbert, A. J. Montabone, E. J. Lemieux, John Dorais, H. Etienne, E. Davis, E. J. Ryan, R. Robertson, L. Girardot and M. Rubenstein.

The menu was as follows :

MENU

STARTING RHEOSTATS.
Anchovy Canape. Celery. Radishes. Olives.

IMPERIAL COMPOUND.
Clear Green Turtle au Madere.

SUBMARINE CABLES.
Filet of Flounders, Marguery.

50 MEGOHMS.
Cucumbers. Pommes Marquise.

ECONOMY COILS.
Vol-au-vent of Chicken, Montebello.

WIRELESS.
Larded Beef Tenderloin, Renaissance.

CLEATS AND BABY PORCELAIN INSULATORS.
French Peas. Pommes Gastronome.

30,000 VOLTS KIRSCH PUNCH.

KICKING COIL.
Roast New Spring Lamb, Mint Sauce.
New Potatoes Rissolees.

MERCURY.
Salade Panachee.

HIGH INSULATION.
Charlotte Windsor. Orange Tarte.
Petits Fours Assortis. Neapolitan Ice Cream.

RUNNING AT 70% BELOW SURROUNDING AIR.

GROUND DETECTORS.
Cheese. Coffee. Fruit. Crackers.

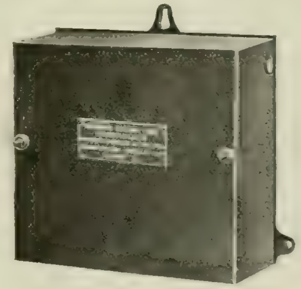
There were three toasts : "The King", proposed by Mr. A. J. Montabone; "The President of the United States," by Mr. W. H. Reynolds, and "Our Guests," by Mr. W. P. Roper. In responding to the latter toast, Mr. Dean expressed his appreciation of the tribute paid to him by his business associates, as well as his regret at leaving Canada.

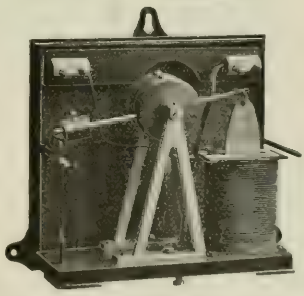
The Contract Department of the Montreal Light, Heat & Power Company are badly advised in propounding contracts in the suburb of Westmount, which would take a Philadelphia lawyer to decipher the rate. The way to meet competition of the Westmount municipal plant, which would be most clearly understood by the residents, would be to take the same base rate as the municipal plant and quote a straight discount. As a matter of fact, the base rate of the municipal plant is 15 cents per k.w., which tallies with the base rate of the Montreal Light, Heat & Power Company. It should, therefore, be merely a case of one discount against the other without the necessity of any fancy figuring, fixed rates and the like.

SHEDRICK'S ELECTRIC LIGHT CONTROLLER.

Mr. C. E. Shedrick, Sherbrooke, Que., was on October 24th, 1905, granted a patent for an electric light controller which he claims possesses several advantages and improvements over all other electric light controllers that have yet been placed upon the market. Its general construction is as follows :

Two iron cups, about three inches in diameter by one-half inch deep, are mounted upon a shaft. The shaft is set in delicate jewelled bearings. The cups are electrically divided by an insulator. A few ounces of quick silver are placed in each cup and the cups hermetically sealed. Extending from the shaft are two arms, one carrying a laminated iron plunger which is suspended in a strong magnetic field, and the other carrying a balance weight. Now, if the balance weight is set for a given number of lights, and more lights are turned on, the magnetic field becomes stronger, carrying the plunger down, while at the same time the insulator, which is stationary with the cups, changes its position, and in doing so divides the bodies of quick





SHEDRICK'S ELECTRIC LIGHT CONTROLLER.

silver, which opens the circuit. The instant the circuit is opened the magnetic field becomes demagnetized, and the balance weight falls back, carrying the cups and insulator until the circuit is closed again by the bodies of quick silver coming together ; thus the circuit will be opened and closed until the excessive lights have been turned off.

Some of the advantages it is claimed to possess over other controllers are : The quicksilver being hermetically sealed in the cups, the instrument can be shipped or carried in any position without losing the quicksilver. The instrument is series connected; simply opening one line of the circuit and connecting the two ends to the binding posts inside the instrument.

No shunt coils to burn out. The instrument cannot possibly be put out of order by turning on excessive lights. The stronger the current through the series winding or solenoid, the faster the circuit is opened, and at ten times the number of lights that the balance is set for there would scarcely be any current passing owing to the rapid oscillation of the mercury cups.

Mr. Shedrick will be glad to furnish further particulars to central station managers who may be interested.

HIGH SERVICE TURBO PUMPING STATION AT TORONTO.

The City of Toronto is installing a pumping station for serving a high pressure fire system which possesses several features of unusual interest. The entire station equipment (contracted for by the Canadian Westinghouse Company) is of the turbine type, power being furnished by steam turbines and the water pressure by multiple stage turbine pumps.

The service to be rendered by this station will be similar in character and extent to that of the Philadelphia high pressure pumping station, now familiar to the public and which is driven by gas engines. As is the case in Philadelphia, the Toronto service plant will supply water at a maximum pressure of 300 pounds per square inch to a high pressure piping net work, covering the district to be protected. Hose connections are made direct, thus dispensing entirely with the use of fire-engines in the locality.

For the present the new high service equipment will

Chart from Records of High Pressure Pumping Station.

comprise two turbo pumping units having a capacity of 5,000,000 gallons per 24 hours at 300 pounds maximum head. It will be installed at the main pumping station, where steam power is at all times available. This fact wasan important and probably the preponderating one in the decision of the City to install steam driven, in place of gas driven apparatus, as the expense of maintaining an individual steam plant under full pressure would have been prohibitive.

TURBINES.

Motive power for each pumping unit is supplied by an 1,100 h.p. Westinghouse-Parsons steam turbine of the same construction that has become standard for electrical work. They operate on dry saturated steam at 150 pounds pressure and a moderate vacuum of 26 inches is supplied by a condenser of the simple jet type. As the highest economy was not considered of paramount importance in this case, the simplest form of condensing plant was adopted. Independent operation is assured by the use of one condenser for each unit. In order to enable the turbines to sustain full load in case of condenser failure, a secondary valve standard to Westinghouse construction may be used which at the same time gives the unit an over-load capacity of 50 per cent. or more when running condensing at the usual speed. An important feature in the operation of the plant will be the speed control of the pumps, which will, of course, be necessary to secure the desired variation in delivery pressure to meet the exigencies of fire fighting. This will be done largely by hand, and provision has been made for a 30 per cent. variation in speed below the normal speed of 1,500 r.p.m. As an auxillary feature, the governor operates as an automatic safety stop, preventing the turbine unit from reaching a dangerous speed should any part of the regular governing mechanism get out of order; this being accomplished by instantly shutting off the steam supply to the turbine.

In the specifications drawn up by the City Engineer, it was stipulated that either turbine or pump should be capable of disconnection for inspection or repairs without disturbing the adjustment of the remaining half of the unit. This is readily accomplished by a split coupling of the flexible type. As both turbine and pump each has two bearings, the two parts of the unit are thus independent.

PUMPS.

Although the centrifugal pumps are not particularly designed for steam turbine driving, yet in this case the design is well adapted for direct connection to steam turbines. They are of the two-stage turbine type as developed by the Worthington Company and manufactured by the John McDougall Caledonian Iron Works, Limited, Montreal. An important and essential feature in the design is the provision of diffusion vanes by which the water delivered by the pump impellers is brought approximately to rest under the static head of 150 pounds per stage. Furthermore, the pumps have been designed so that the dynamic forces acting in the direction of the shaft are approximately balanced, thus relieving the turbine shaft from axial thrust. The pumps take water axially at the center under a suction head of 10 to 15 ft., both delivering into a horizontal 24-in. main connected with the high pressure system. In cases of large fires and high buildings where maximum pressure head is necessary, the two pressure stages will be operated in series; where lower pressure is desired, the speed of the unit will be reduced in proportion. In cases of small fires, however, where only moderate pressures are required, one pump stage will be eliminated by a by-pass valve delivering suction water directly to the succeeding stage. These valves will be electrically operated.

The complete pumping units are extremely compact, being only about 25 ft. in length over all and set at 10 ft. centers. This close spacing is largely due to the possibility of locating the condensing plant for each turbine directly beneath it in the foundation.

OPERATION.

The operation of a high pressure fire system such as is being installed at Toronto presents many novel conditions not arising in ordinary power work. Principal among these is the necessity for quick starting, and the appended chart, taken at random from the records of the Philadelphia high pressure pumping station, show these characteristics very clearly. The chart records delivery pressure at the service station. Alarm sounded at 10:15 p.m. At 10:40 the pressure had to be increased to 250 pounds and maintained until after mid-night, when the fire was completely conquered; a pressure of 125 pounds was then sufficient for "wetting down" the debris. The morning fire was of shorter duration but required full pressure.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstaces warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the moth preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.

Ques. No. 1.—Explain the difference between delta and star connections in dynamos and transformers, and difference in voltage, with advantages one way has over the other in a three phase system. Also show where the "1.73" comes from in calculating horse-power.

Ans.—Consider three transformers, the terminals of the first being numbered 1 and 2; the second, 3 and 4; and the third 5 and 6. In the delta connection, terminal 1 is connected to terminal 6, terminal 2 is connected to terminal 3, and terminal 4 is connected to terminal 5. In the star or "Y" connection, terminals 2, 4 and 6 are connected together, and terminals 1, 3, and 5 connected to the three outgoing lines. In the delta connection, the three outgoing lines are connected to the junctions between terminals 1 and 6, 2 and 3, and 4 and 5. In small plants the delta connection is almost invariably used, inasmuch as one transformer can be disconnected, and still three phase transformation can be made with the other two transformers with their original connections. In the case of the star system, if one transformer is damaged this will cut the other two out of service. However, in large plants, where there are a great number of groups of transformers, and the line voltage is very high, the star connection is usually used, for the damaging of one set of transformers will mean slightly reduced capacity but not a complete shut down. With the delta connection, the full line voltage is across each transformer, and consequently each transformer has to be insulated for the line potential. With the star connection, however, the voltage across each transformer is only 58 per cent. of the line voltage, and consequentially where very high potentials are used, the "Y" connection allows a mechanically smaller transformer to be constructed as less insulation is needed. The constant "1.73" is not used in calculating horse-power, but rather in the figuring of the ratio between the current in any one line of a three phase system, and the total current in the three lines. If the current in each of the three lines is the same, then any one line multiplied by 1.73 equals the total current in the three lines. The derivation of this constant is as follows: A three phase delta connected machine practically consists of three single phase windings, the current in each of these windings being one-third of the total current in the machine, assuming, of course, that the current in each winding is the same. If this energy were transmitted over three distinct single phase lines, each line would have flowing in it one-third of the total current, but this method, as you are aware, is not the practice. The ends of the three single phase windings are connected, as explained above, and one wire is run out from each of these connections. Therefore, each of these wires will carry the current generated in one phase and the current generated in the adjacent connected phase. Assume, for the sake of argument, that the value of the current in each of these phases is equal to 1. From this it might be implied that the sum of two currents was equal to two, but this is not the case, inasmuch as the angle of the two currents differs 120 degrees. The resultant of these two currents, each equal to one, and 120 degrees apart, is equal to 1.73. Now, the sum of the three currents is equal to three, while the current in each wire is equal to 1.73. The square of 1.73 is also equal to 3, and therefore if the current in any one wire be multiplied by the constant 1.73, the product is the total current of the system.

Ques. No. 2.—I have a small dynamo, direct current, 40 amperes, 110 volts, which gets hot at the armature after running about one hour, and the lights get dim. Have about 70 lights on this machine, which is of the 4 pole type, equipped with carbon brushes. Would you kindly tell a subscriber how to remedy this trouble?

Ans.—A 40 ampere, 100 volt dynamo should be quite capable of handling at least 70 16 candle power lamps, and there should be no occasion for such a machine to show a temperature rise of more than forty degrees centigrade, when operating under full load continuously. A rise of forty degrees centigrade is equivalent to a rise of seventy-two degrees Fahrenheit, and all such temperatures are taken above the temperature of the surrounding air. It is difficult to say what is the matter with the generator, without an actual examination, but it is quite possible that the machine is simply rated at more than its normal capacity. Unless a person is very experienced, it is a difficult matter to estimate the rise in temperature unless a thermometer is used. We would suggest that you take the temperature of the windings on this machine with a thermometer, and the temperature of the air, to ascertain whether or not the rise is greater than that specified above. The fact that the lamps get dim after running for some time could be attributed to the machine running at a lower speed than that for which it is designed. Under such a condition, the field rheostat could be adjusted to give proper voltage when the machine was cold, but after a run of some hours the resistance of the field would increase to such an extent that sufficient current could not be forced through it to give full voltage at the brushes. We would suggest that you ascertain the proper speed at which this generator should run, and if same is now running below normal speed, change the pulley combination so as to remedy this trouble.

Ques. No. 3.—Is it absolutely necessary in the case of a single water wheel, vertically set, that the centre line of the wheel shaft should coincide with the centre line of the horizontal shaft? If it were off centre, say one-eighth inch, what would be the result?

Ans.—In answering the above, we would refer our subscriber to question No. 4 in our February, 1906, issue, which covers the operation of spur gears. An installation, where the centre lines of the wheel shaft and the horizontal shaft do not coincide, shows a decided carelessness on the part of the erecting engineer, for bevel gears give sufficient trouble, even when properly set, without putting up the machinery with one of the shafts off centre. The result of such an error in installation would be that the gears would not run smoothly, and also that the life of such a setting would be considerably shorter than that expected. Nothing serious would result from such a difference in centre as you mention, beyond the above points mentioned, provided the gears were large. Naturally the additional wear which would be experienced implies that there would be considerable friction in the gears, which friction would mean an unnecessary loss of power.

Structural Design of Towers for Electrical Power-Transmission Lines

By Joseph Mayer, M. Am. Soc. C. E.

(Continued from March issue)

The Foundation.—There are two different types of foundation of such towers.

1. If the three or four posts are not more than 5 ft. apart at the base the foundation is frequently a cylindrical or prismatic block of concrete. The posts may be embedded in the concrete or anchored to it by means of bolts. When the tower is exposed to lateral pressures the upper part of this block presses horizontally against the earth on the leeward side, the lower part on the windward side. The upward pressure on the base balancing the weights is on the leeward side. There is also a shear between the vertical sides of the concrete block and the earth ; this acts upwards on the leeward and downwards on the windward side. These three groups of forces must produce a moment equal to the overturning moment of the wind or other lateral force.

2. When the three or four posts are far apart a separate mass of concrete is provided for each post. These masses are exposed to downward and upward forces at small angles against the vertical. The weight of the blocks and the friction between them and the earth are the principal opposing forces. To reduce the amount of concrete required, such foundations are sometimes built with a platform made of reinforced concrete at their base. The weight of the earth over this platform (contained in a pyramid sloping out from the edges at an angle of 45 degrees in all directions) is counted as resisting the upward pull of the anchor bolts and a factor of safety of 2 is adequate.

The cost of the foundations is a quite important part of the cost of the towers, their accurate calculation is therefore desirable. The second type offers no special difficulty. For the first type telegraph poles furnish the most reliable precedent. It may be safely assumed that during the long years they have been in use the depth to which they must be set to make the resistance of the ground equal to their strength has been correctly ascertained.

The safe strength of a telegraph pole, or the moment it can safely resist, may be taken with a factor of 5 as

$$m = \frac{\pi d^3}{32} 1,500,$$

where d is the diameter of the pole at place of maximum moment in inches, and the moment m is in inch-pounds.

The usual practice in setting poles is about as follows :

Poles 12 ins. diam. are set 5 ft. 0 ins. deep.
Poles 12 1-2 ins. diam. are set 5 ft. 6 ins. deep.
Poles 13 ins. diam. are set 6 ft. 0 ins. deep.
Poles 14 ins. diam. are set 6 ft. 6 ins. deep.
Poles 16 ins. diam. are set 7 ft. 0 ins. deep.

NOTE.—The diameters are 6 ft. from butt.

The largest bending moment to which the poles are exposed occurs at about 1-4 the depth of the buried portion where the diameter is 1-4 in. more. From the above formula for the moment in inch-pounds which a timber pole can safely resist we obtain the moment in foot-pounds : $M = 12.27 d^3$ We obtain for different diameters at 1-4 the depth of buried portion the following safe moments in foot-pounds, and the usual depths h of setting.

d ins.	M ft.-lbs.	h ft.	h ins.
12.25	22,550	5	0
12.75	25,430	5	6
13.25	28,540	6	0
14.25	36,030	6	6
16.25	52,650	7	0

Concrete foundations of towers, as here contemplated, are of larger dimensions than the buried part of the telegraph poles, and they must safely resist much greater moments. We must, therefore, ascertain how a change in the dimensions will affect the moments which can be resisted. The safe resistance of the earth against the overturning of the foundation may be sub-divided into three parts.

I.—The moment of the horizontal lateral forces acting on the vertical sides of the foundation. These forces per square foot of surface increase about in proportion to the depth. The total amount, therefore, increases in proportion to the square of the depth of the foundation ; it also increases in proportion to its diameter. The leverage of the two opposite resultants of the horizontal forces increases as the depth of the foundation. The moment of these horizontal forces opposing the overturning of the foundation is therefore proportional to its diameter and to the cube of the depth.

II.—The vertical shears between the foundation and the earth or the frictions are proportional to the horizontal pressures ; these latter are proportional to the diameter and the square of the depth ; the same applies therefore to the former. The leverage with which these frictions act is proportional to the diameter. The moment of these frictions which is the product of their amount into the leverage is therefore proportional to the square of the depth and the square of the diameter.

III.—The upward pressure from the base is equal to the weight carried. When the foundation is exposed to overturning forces this upward pressure acts on the leeward side, its leverage is approximately proportional to the diameter. The weight of the foundation is an important part of the whole weight ; if it were the whole weight this last moment would be proportional to the depth and the cube of the diameter.

Thus, if the diameter and depth of base are increased in the same proportion the moment which can be safely resisted increases approximately with the fourth power of the lineal dimension of the foundation. The only item which does not comply exactly with this ratio is the resisting moment of the pressure on the base due to weight of pole and wires. This item is a small one with telegraph poles and will not materially vitiate the inference here drawn.

For calculating foundations with different ratio of depth to diameter and for square prismatic foundations a formula is required giving their safe strength as a function of diameter or side of the square cross section and the depth. It is a safe assumption that a square foundation will be stronger than a round one having as cross-section the circle inscribed in the square. From the above-cited figures for experience with telegraph poles we may reliably conclude that in ordinarily firm soil a round or square foundation 13 1-4 ins. in diameter and 6 ft. deep will safely withstand a bending moment of 28,500 ft.-lbs. The safe resistance of soil of various kinds against forces acting vertically is approximately known. From this the safe resisting moment of the forces acting on the base may be estimated and subtracted from the 28,500 ft.-lbs., and from the remaining moment the safe lateral pressure per square foot of the earth on the foundation can be obtained. This safe lateral pressure or safe passive earth pressure can also be obtained from published results of experiments. This latter method has been tried by the writer, but the results obtained differ so widely from the actual experience with telegraph poles that they are quite misleading.

Concrete foundations are mostly square or rectangular prisms ; their size can be calculated if the safe vertical pressure on the base, the safe horizontal pressure on the sides, and the safe coefficient of friction between the sides and the earth are known. If the safe coefficient of friction is assumed to be 1-3, if the safe pressure on the bottom per square foot is assumed to be 1,160 lbs. multiplied with the depth below surface in feet, and if the safe horizontal lateral pressure per square foot is assumed to be 1,160 lbs. multiplied by the depth below surface in feet, then calculation gives for a concrete foundation 13 1-4 ins.

square and 6 ft. deep, a safe strength to resist an overturning moment of 28,500 ft.-lbs. Unless the present practice of setting a pole of this diameter 6 ft. deep is in error such a foundation, even if round instead of square, will resist a moment of 28,500 ft.-lbs. with a factor of safety of 5. The lateral pressure on the ground and the friction due to it are the only important items in the stability of telegraph poles. The constant of 1,160 lbs. for the safe lateral pressure of the earth at a depth of 1 ft. below ground must therefore be approximately correct. To be, however, quite on the safe side and to allow for greater variations in the nature of the ground than is usual with telegraph poles, it would be better to take, if but one kind of foundation is used, 800 lbs. multiplied by the depth in feet as the safe lateral pressure per square foot. In a power transmission line with three or six large strands the greatest lateral forces occur during tornadoes and in warm weather; on a telegraph line the greatest lateral forces occur with sleet-covered wires when the ground is frozen. From this it follows that in wet ground the foundations of a telegraph line are strengthened by frost when the largest forces occur, while this is not the case with a power transmission line. Greater caution in wet ground is therefore required with the latter. In setting telegraph poles the nature of the ground is taken into account in selecting the depth of setting, which is varied somewhat according to it. In designing concrete foundations for steel towers it is advisable to make at least two designs, one for compact gravel with 1,000 lbs. unit pressure at unit depth, and another with 600 lbs. where there is a considerable depth of soft soil. The latter foundation will be from 1 ft. to 1 1-2 ft. deeper than the former.

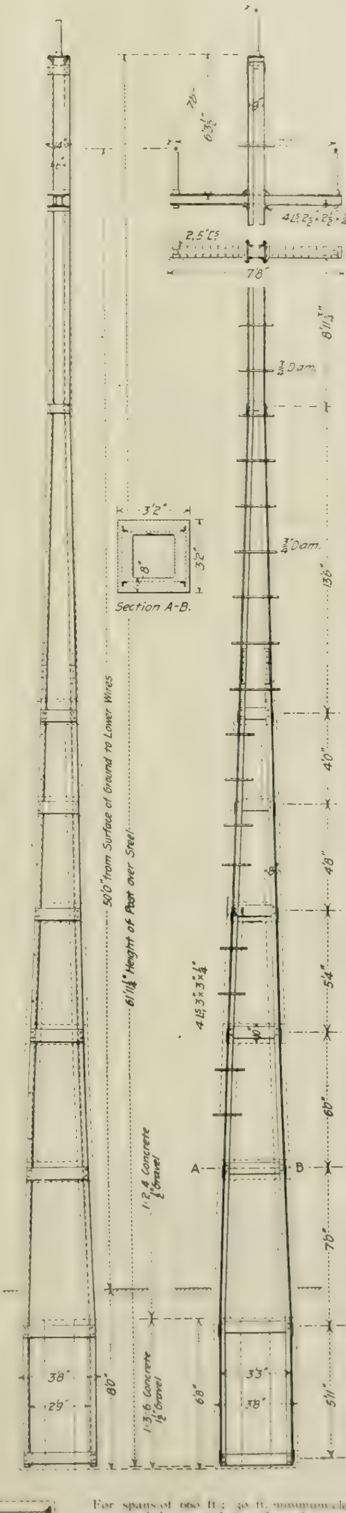
On a subject which is so variable as the resistance of the ground against lateral forces opinions of different engineers will differ considerably, but the practice in setting telegraph poles has become fairly uniform; it seems, therefore, most reasonable to determine from this the practice which should be followed for larger but similar structures. This is certainly a better guide than mere guessing. There are special situations where a foundation having a buried platform at its base is more suitable than a prismatic body of concrete; this is especially the case where rock is near the surface or where soft ground overlies a layer of gravel.

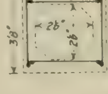
Design of the Tower.—If steel towers are designed in accordance with the specifications here suggested it will be found that for three large strands pyramidal towers consisting of four angle irons latticed on four sides, anchored by bolts to a square prism of concrete, are most economical. For two high tension lines a considerable distance apart, each of three strands, two triangular bents with their planes parallel to the line, braced together by struts and diagonals, are most suitable, and have been used on several recent lines.

Steel towers so far built for power transmission lines have generally metal from 1-8 in. to 1-4 in. thick; they will, therefore, unless frequently painted, be very short-lived. To obtain a durable structure the steel must be embedded in concrete.

In France and Italy towers have been built of reinforced concrete in the shape of octagonal truncated pyramids with a large conical hole running from top to bottom. The reinforcement consists of plain steel rods, which are surrounded by wire wrapping. The transmission wires are attached to the shafts by small brackets. These towers are for moderate voltage with small insulators. The brackets are therefore short and the breaking of a wire produces but little torsion.

Fig. 2, herewith, shows a reinforced concrete tower for three strands of 350,000 c. m. for 60,000 volts and 400-ft. spans, which was designed for a proposed transmission line. The double-channel brackets are not directly connected with the steel reinforcement. The torsional strength of the tower mainly depends on that of the concrete; it is therefore moderate. On this account it was advisable to space wires as shown, instead of in equilateral arrangement. Further, to obtain a safe line there must be intro-





For spans of 400 ft.; 30 ft. minimum clearance, 20 ft. maximum deflection. Assumed wind pressure, [illegible] lbs. at each insulator, and 40 lbs. per vertical foot of tower, on equal pull, 1,000 lbs. at one wire or [illegible] lbs. at each wire, assumed ice coating ½ in. Material for one tower: All metal, [illegible] lbs. [illegible] and [illegible] concrete, [illegible] cubic yards.

Fig. 3. Four Post Reinforced-Concrete Tower with Prismatic Base, for Single Three-Phase Power Transmission Line.

duced at intervals guyed towers to which the wires are firmly attached by means of double insulators. The method of guying is also shown in the drawing. The wires should be able to slide easily at the ordinary towers, so that these are not exposed to much torsion. The guys of the guyed towers must be attached to the ends of the brackets and run in both directions of the line, so as to relieve the towers of torsion and longitudinal forces. The guys are not durable and must be occasionally renewed.

These towers have the following defects: Neither the top insulator pin, nor the brackets, nor the base are directly connected with the steel reinforcement. The steel is arranged in an octagon. For any direction of the overturning forces a part of the steel and most of the concrete is unfavorably situated. The cross-section shows the position of the neutral axis, assuming that the concrete carries no tension. Most of the concrete is on the tension side, where it is of no use. Octagonal hollow towers with reinforcing rods are best for moderate voltages where short brackets can be used, and for moderate spans which require towers of not more than 40 ft. height above ground. Such small towers do not require a platform base; an enlargement of the diameter where the tower is below ground will give sufficient strength of foundation.

To make a good connection of the steel reinforcement with the top insulator, with the cross arm and with the platform base, if such is required, the reinforcement should be in the shape of angles instead of rods. In this case riveted connections can be made and a much greater torsional strength of the tower can be secured, thus avoiding the use of guyed towers. To secure an economic distribution of the material to resist the overturning forces in the directions normal to and along the line, the steel and concrete should be placed in the four corners of a square or rectangle. A tower with four posts is the logical consequence. For small towers this sub-division of the material is not practicable, since the separate members must have considerable size to resist the bending strain due to torsion. For large towers it is most economical and avoids the use of the troublesome core.

Such a tower, as designed for 660-ft. spans, is shown in Fig. 3. It has horizontal struts at short intervals, but no diagonals. The tower may be considered as consisting of two bents normal to the line, connected together by longitudinal struts. The two legs of each bent are convex toward the centre line, giving the tower a concave profile. To avoid bending moments in the legs due to wind pressure and the absence of diagonals, the polygon of the two legs of each bent must be so determined that the legs in each story, if continued, would meet at the centre of the wind pressure above that story. This will make the wind strains in the omitted diagonals zero, and bending strains in the posts due to the absence of diagonals are avoided. This is not accurately but approximately true, since the height of the centre of wind pressures changes to some extent, but the bending moments in the posts due to wind pressure will be small. The forces acting in the direction of the line arise partly from wind, partly from the breaking of a wire. The position of the centre of these forces will vary greatly; they inevitably produce bending strains in the legs if no diagonals are used. The height of the stories and the dimensions of the legs must be so chosen that these bending strains, together with the other strains occurring at the same time, can be safely resisted. The torsion arising from the breaking of a wire at the end of the cross arm produces the largest bending moments in the legs. These are proportional to the height of the stories and inversely proportional to the distance between the legs. The stories may therefore gradually increase in height toward the bottom where the legs are farther apart.

A simple design is obtained if the tower is built so that the four legs are in the corners of squares through its whole height.

The concrete covering of the steel makes the tower as durable as a masonry structure. It greatly increases the compressive strength of the four posts. The concrete in the posts shown takes 4-5 of the compression, the steel 1-5. The amount of steel required is therefore determined by the tension and bending strains in the posts. The bending strains are moderate if the stories are low, and if the wires are so attached to the insulators that they can slide with small friction. The angle lacing on four sides, which is necessary if no concrete covering is used, is replaced by light tie plates. The maximum tension in the tower legs which mainly determines the cross-section of their steel is considerably smaller than the maximum compression. If the concrete covering were omitted the posts would have to be calculated by the use of a column formula to resist the compression; their section would have to be much larger than that of the steel of the concrete-covered posts.

With steel towers the top of the concrete block forming the foundation should be from 6 ins. to 1 ft. above ground. With concrete-covered towers the foundation block can economically stop about 1 1-2 ft. below ground, without thereby materially weakening the foundation. The greater weight of the concrete-covered tower adds materially to its stability wherever the foundation block has considerable horizontal dimensions. For the size of tower shown in Fig. 2 the cost is in many situations reduced by the concrete covering, since the steel saved more than balances the expense of additional concrete required.

Reinforced concrete towers, such as have been built in France, which are of small size, can be manufactured at a suitable place, transported to the site and erected. The principal advantage of making them hollow is the ease of transportation and erection. Solid towers could only be transported by rail and erected by a heavy derrick. The larger sizes for which four-legged towers are suitable require a good road or railway to transport them. Where these are not available the towers must be built on their site, and then erected. The solid materials, the water and the plant for erection may have to be transported over considerable distances through the fields; this makes the concrete expensive and may make the towers, under unfavorable circumstances, more expensive than steel towers.

The proper general dimensions will vary with size and number of wires, the span used and the amount of ice which must be allowed for. These towers are not suitable for spans of less than 400 ft. if only three large strands are to be carried. Where a large number of strands or wires are to be carried, requiring high and strong towers for short spans, they may be used with advantage for much shorter spans. Where but little torsion and small forces acting in the direction of the line must be provided for, they are especially suitable, since the four posts will then be exposed to but small bending moments. The stories can then be made high and the posts of small cross-section. To reduce the weight of the towers and to facilitate their transportation and handling the prismatic foundation may be made with a large octagonal hole.

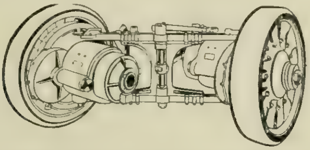
At a meeting of the shareholders of the Erie & Ontario Development Company, Limited, recently held at Welland, Ont., the organization of the company was completed and steps taken to begin work. The capital of the company is $96,000. The ollowing were elected as directors: Messrs. D. W. Allen and S.H. Crossman, of Buffalo; A. Nelson, of Toronto; E.A.C. Pew, Welland; and D'Arcy Scott, Ottawa.

The Maritime Power & Tramway Company are seeking incorporation from the New Brunswick Legislature to enable them to build an electric tramway from Moncton, N. B., to Amherst, N. S., to connect with a system to be constructed in Cumberland county by the Nova Scotia Legislnture. The proposed capital stock is to be $450,000. The company is incorporated in Nova Scotia under the name of the Maritime Coal & Railway Company, with a capital stock of $2,000,000. In addition to operating a tramway the company propose to generate and sell electric power. The applicants are Senator Mitchell, of Montreal, Mr. David Mitchell and Dr. C. A. McQueen, of Amherst, and Mr. Henry Hunter, of Westchester.

ECONOMY OF TRANSIT WITH HEAVY LOADS.

There seems to be absolutely no limit to the development and extension of commercial business in the electrical field. So frequently are we brought face to face with some wonderful invention which performs what appeared an impossibility and opens out an entirely new field for the use of capital and labor, that we have ceased to be even surprised, and look constantly and expectantly for "the next."

Heretofore from a commercial and economical standpoint, the movement of heavy loads either for transit or freight purposes, aside from railroads and boats, has not been a success. While the improvement in gasoline driven vehicles has been constant and amazing as regards speed, noise and simplicity of operation, as a commercial venture they are more costly than horses, too liable to get out of order and require an expert to operate them successfully. To fully solve this problem, it is necessary that the vehicle can be manipulated and controlled by an ordinary driver, that it be permanently reliable in operation, and considerably cheaper than horses.



FRONT AND BACK WHEELS AND MOTORS.

With all present systems of moving loads, there is a great loss transmitting the power to the wheels, and from 150% to 200% more power is required to start a load than is required to afterward run it. This latter means is an insuperable objection from the standpoint of economy of power. The owners of the Berg Four Motor Equipment Patents claim to have successfully solved this problem. It has taken several years time and the expenditure of over $100,000 to perfect this system, but their claims appear to be fully substantiated by the results.

The most valuable features of this equipment are, first, that the motors are built adjacent to and attached directly to the wheel hubs of a vehicle, thus supplying the power direct and making the wheels the actual driving units; and secondly, that each wheel, front and back, are thus supplied, resulting in the power being immediately under the load, and, as it were, lifting the load along instead of, as with other systems, having to push the load along from the rear.

Actual tests by leading electrical engineers and experts in Cleveland and Detroit show conclusively that this equipment requires only 25% greater power to start a load than to keep it moving, showing the great economy of this system.

The Four Motor equipment will be generally used with storage battery power, but in exceptional cases such as where charging plants are not obtainable, small gasoline engines are used to generate the power for the motors.

The Emigration car built for the Canadian Government, and successfully operating in England and Scotland, is equipped

TRANSIT CAR.

with these motors, and owing to the difficulty of finding charging stations in the small villages, is so equipped, with a small gasoline engine to generate the power for the motors.

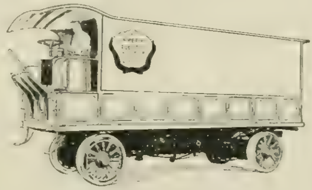
A company has been formed in Toronto to control and develop these patents in Canada and their first local company is now being formed, in the nature of a transit company, to operate both sight-seeing coaches and busses, giving regular routes and service in the city of Toronto. Their cars will seat thirty persons and will be equipped with comfortable spring upholstered leather seats, electrically lighted and driven, with push buttons at each seat for passengers' use, and will be fitted with 7 inch solid rubber tires. They will serve the better sections and districts of the city where the ordinary street railway would not be tolerated.

These transit companies will be formed at other important Canadian centres as fast as possible, and the type of car used will be similar in a large degree to the illustration shown herewith.

The system has been tested in three large cities in the United States, with excellent results in each case.

When the transit company is thoroughly organized, the owners of the patents will at once license or organize a strong manufacturing company to construct both the transit cars for the various transit companies and freight vehicles of all kinds, stage and hotel busses, automobiles, etc., etc., fitted with their special motor equipment to order and for sale.

As an instance of the success of such, the large dray shown herewith has been operating for nearly two years, carrying 7½



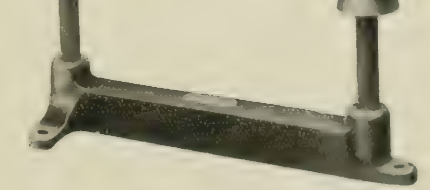
LARGE DRAY.

tons of stoves at each trip, which is more than two large lorrie loads, and taking three trips to the lorries' one, and doing this at the same or slightly less cost. This means that this dray is doing the work of four to five teams at the cost of one. The fact that the owners of the dray, a large stove manufacturing company in Detroit, so testify over their own signatures, is an excellent testimonial of the value of these inventions, and the verification of the claims made for them.

It will be interesting to watch the development of these companies and the demonstrations of the equipment through the coming summer months. Anyone requiring information regarding same is referred to Mr. E.C. Hill, Room 75, Confederation Life Building, Toronto.

HOOK TYPE OF SWITCH.

Herewith is shown a Hook Type Switch manufactured by the T. & H. Electric Company, of Hamilton, Ont. This switch has been largely used on the new power transmission lines and we



HOOK TYPE OF SWITCH.

understand has given general satisfaction. The switch is opened from the floor by means of a pole, thus protecting the operator. It is used as a selector switch and for opening circuits on which alterations or repairs are to be made. Full particulars will be sent to any one mentioning the ELECTRICAL NEWS.

The St. Jerome Power & Lighting Company, St. Jerome, P.Q., have retained the services of Mr. R. S. Kelsch, consulting engineer of Montreal, in connection with their new power development.

PERSONAL.

Mr. H. Stafford, of Port Arthur, Ont., has taken a position with the Great Lakes Dredging Company as electrician, looking after the lighting plants, etc., on the dredges of the company.

Mr. F. J. Bell, who was with the Canadian General Electric Company for many years and formerly was in business for himself in Winnipeg, has joined the Montreal office of Allis-Chalmers-Bullock, Limited.

At a recent meeting of the Board of Light Commissioners, Brockville, Ont., Mr. Robert Wells was appointed temporarily to the position of chief engineer of the electric station as successor to Mr. A. W. Brown.

Mr. Clarence L. Collens, late general manager of the International Acheson Graphite Company, has been appointed superintendent of the generating plant and distributing system of the Canadian Niagara Power Company.

Mr. G. L. Stewart, who has been connected with the Montreal Electric Company for a number of years, has accepted a position as electrician with Messrs. Alexander & Miller, Peterboro, Ont. Mr. Stewart is an expert electric wireman and capable of taking charge of large contracts.

At a meeting of the Board of Directors of the Westinghouse Electric & Manufacturing Company, held Tuesday, April 10th, Mr. L. A. Osborne, formerly Third Vice-President of that company, was elected Second Vice-President to succeed Mr. Frank H. Taylor, resigned. Mr. Taylor, who is also a director of the company, will retain his seat on the Board. Mr. Osborne as Third Vice-President had the direction of the engineering and manufacturing activities of the company. As Second Vice-President he will assume the direction of the commercial activities of the company, while retaining those of the Engineering Department.

SPARKS.

A by-law has been carried in Meaford, Ont., by a large majority, to guarantee a loan to the Georgian Bay Milling & Power Company for the purpose of further developing a water power to supply electricity.

A new exchange building for the Nova Scotia Telephone Company is to be erected at the corner of La Planche and Victoria streets, Amherst, N. S., for the construction of which tenders have been taken by the manager, Mr. J. H. Winfield, 26 Salter street, Halifax, N. S.

The Falls Power Company, Limited, of Welland, Ont., has recently been granted incorporation to engage in developing electric power, etc. The head office of the company is Welland, Ont., and the capital stock $10,000. The charter members are Messrs. David Ross, B. J. McCormick, G. C. Brown, J. E. Cohoe and H. A. Rose, jr.

At the annual meeting of the Havelock Electric Light & Power Company the following officers were elected for the ensuing year: President, Mr. Wm. Fairman; vice-president, Mr. Geo. Young; second vice-president, Mr. Wm. Webb; manager, Dr. Holdcroft; secretary, Mr. Alex. Rose. The financial outlook for the company for the future is exceedingly bright.

Mr. F. H. Thomson, of Boston, Mass., has recently been appointed assistant general manager of the New Brunswick Telephone Company, with headquarters at Fredericton. He will have general supervision over the company's lines and will attend to the development of new business. Mr. Thomas has been twelve years in the employment of the New England Telephone Company.

An electric road to be owned, controlled and operated under the direction of the farmers and other residents of East Kent, is an enterprize seeking a charter from the Ontario Legislature through the instrumentality of their representative, Mr. P. H. Bowyer, M.P.P. The road is to serve a large agricultural community at present without travelling and shipping facilities. It will extend from the Erieau Lighthouse, through Rondeau Government park to Morpeth and thence to Ridgetown, Thamesville, Dresden and Wallaceburg. The provisional directorate includes Messrs. B.W. Wilson and Robt. Hamilton, of Ridgetown; Dr. Stewart, of Thamesville; Mr. D.A. Gordon, M.P., of Wallaceburg, and Mr. H. D. Smith, of Chatham.

The annual meeting of the Canadian Westinghouse Company was held at its office, Hamilton, Ont., on March 27th. The annual report showed the company to be in a prosperous condition, the amount carried forward after paying a 6 per cent. dividend being $232,041.35. Mr. George Westinghouse was re-elected as president, Mr. Paul J. Myler as general manager, and Mr. John H. Kerr as secretary.

An application is to be made to the Ontario Legislature for the incorporation of the Hamilton, Galt and Guelph Railway. It is proposed to construct and operate a railway by means of electricity or other motive power from the city of Hamilton to the village of Elmira, and passing through the towns of Galt, Preston, Berlin and Waterloo, and also from the city of Hamilton to the towns of Elora and Fergus and passing through the city of Guelph.

The citizens of Innerkip, Ont., at a recent meeting organized the Innerkip Rural Telephone Company and elected the following provisional officers: President, Dr. J. D. Hossack; vice-president, Mr. James Montgomery; secretary, Mr. George Dobson; treasurer, Mr. Joseph Gillespie; directors, Messrs. E. M. Johnston, A. N. Hopson, J. W. Cowing, T. Whiteside and John Bickell. It was decided to issue stock to the amount of $2,000.

Mr. John Mackay, liquidator of the Southern Light & Power Company, Limited, will receive tenders up to April 30th for the purchase of the properties of the company, which was organized for the purpose of developing electrical energy by hydraulic power at Erindale, a village situated about fifteen miles west of Toronto. The general scheme of development, which has been partly carried out, involved the building of a dam across the Credit River at Erindale and the conveyance of the water by means of a concrete-lined tunnel to the power house. The company is at present selling electrical energy in the villages of Streetsville and Erindale, this being developed by a temporary steam plant at the latter place. They are also operating a steam plant at the Liszt piano factory on Sorauren avenue, Toronto.

A site for the W. E. & L. S. power house at Kingsville, Ont., has been secured. The building will be a one story structure, 115 x 136 feet, and will be constructed under the direction of Messrs. J. Harper, of Philadelphia, and C. McCauley, of Detroit. The power house, repair shop and car barns will be under one roof. This will be the only power house on the line between Chatham and Windsor, and the plant to be placed in it will cost $1,0,000. It is intended to have the road open between Kingsville and Windsor by July 1st. The two 750 h.p. engines are being built by Goldie & McCulloch, of Galt, the electrical equipment will be furnished by the Canadian Westinghouse Company, and the cars are being made by the Ottawa Car Company. The Keystone Construction Company, of Philadelphia, have the contract for constructing the line.

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First Report of the Hydro-Electric Power Commission

The first report of the Hydro-Electric Power Commission was made public last month. This Commission was appointed by the Ontario Government and was composed of Hon. Adam Beck (chairman), and Messrs. George Pattinson and John Milne, with Mr. C.B. Smith as chief engineer. The following are the matters upon which the Commissioners were authorized and directed to report :

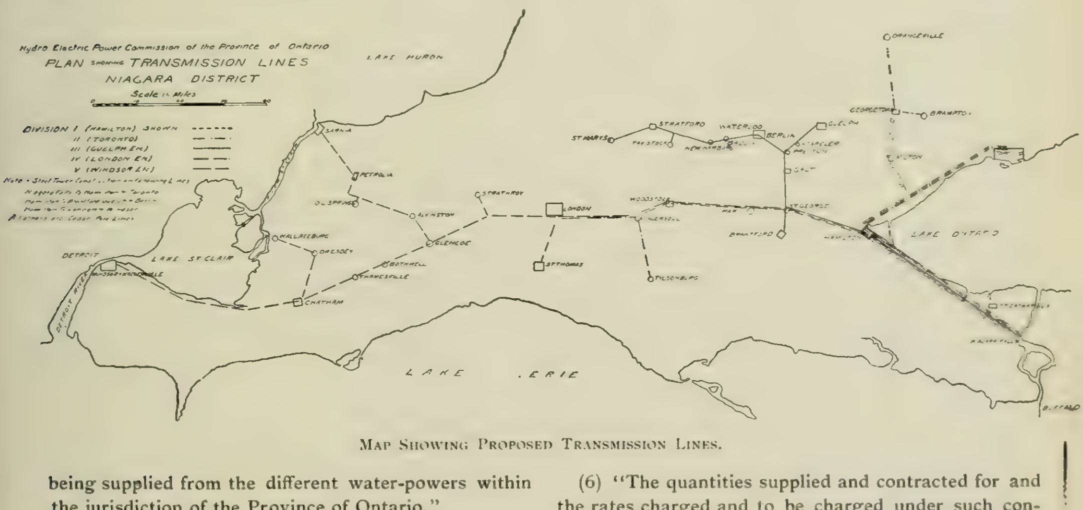
(1) "The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different water-powers within the jurisdiction of the Province of Ontario."

(2) "The location, capacity, and capital cost of development of the various water-powers within the legislative jurisdiction of the Province of Ontario at present undeveloped but whose development is required to supply the present and probable needs of the surrounding districts, and to ascertain the probable cost of the attendant transmission plant necessary to the utilization of electrical and hydraulic powers to be provided from the aforesaid water-powers within the respective surrounding districts."

(3) "To ascertain the rates or prices that would require to be charged the various classes of consumers of hydraulic or electric power within the respective districts in order to meet all expenditure of maintenance and operation."

(4) "To enquire into and ascertain the annual savings accruing to the consumers in the various districts aforesaid by the substitution of the rates or prices in the next preceding paragraph for the rates paid at present in the said districts so far as the Commissioners may be able to ascertain or estimate them."

(5) "To enquire into and ascertain the cash capital cost of the hydraulic and electrical power undertakings of existing companies located within the Province of Ontario; the capacity and state of development thereof."



Map Showing Proposed Transmission Lines.

(6) "The quantities supplied and contracted for and the rates charged and to be charged under such contracts by these companies for hydraulic and electrical power."

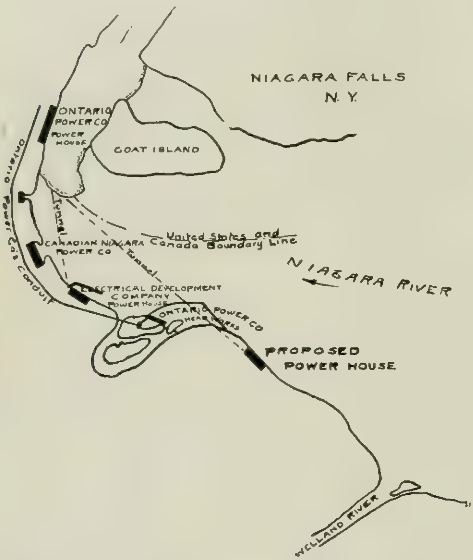
(7) "The actual present value of the said undertakings, or such of them as may be required, after making such fair and reasonable allowance for existing conditions as in the judgment of the Commissioners seems necessary or expedient."

In this first report the Commissioners deal only with that part of South-Western Ontario which, roughly speaking, lies south of the latitude of Toronto, but including Toronto, and which, for the purposes of this report, may be called the Niagara district.

The demand for electrical power will in almost all cases, under present conditions, be limited or regulated by the cost of electricity as compared with that of steam,

gas or other local source of power. The cost of electricity is dependent upon the distance transmitted and the quantity transmitted. As it is only feasible to transmit the power in large quantities, trunk transmission lines capable of carrying large quantities must be constructed at the outset, and, therefore, the cost increases with the distance, and a point is eventually reached at such a distance from the generating station that electrical power can no longer compete with steam or other local power.

Again, the exhaust steam, and heat, from the steam plant of some factories is used in the process of manufacture, and it could not be expected that electricity would be adopted by manufacturers of this class for power only, as their production of steam and heat for manufacturing purposes, apart from power, would increase rather than diminish their expenses; and in many instances waste material is used in the production of steam; such industries have been excluded from



Hydro-Electric Power Commission Report—Location of Proposed Power House and Present Power Houses.

a consideration of the extent of the market at present in sight.

The capital cost of abandoning steam plants would also in many cases be considerable, and the ability of small users of power to bear this loss must always be a factor in the finding of a market.

In order to ascertain the probable market, however, the Commissioners caused enquiries to be made in the various manufacturing centres in the district, with the following results: They are satisfied that a market for at least 50,000 horse-power could be obtained within a reasonable radius of Niagara Falls, as soon as transmission lines can be constructed, and this could be increased to at least 100,000 H.P. within five years thereafter.

In order to ascertain the cost of delivering electrical power in large quantities at particular distances, the Commissioners made computations with respect to all the muncipalities (as localities and not as corporate bodies) which could be conveniently supplied from Niagara Falls, numbering in all thirty-nine.

The Commissioners call attention to the fact, that when electricity is delivered at a municipal sub-station as above, the cost of distribution amongst the consumers within such municipality must be added to this price in order to determine the cost to the individual consumer.

THE CHIEF ENGINEER'S REPORT.

In studying the question of the distribution of Niagara power throughout Southwestern Ontario, the chief engineer, Mr. C. B. Smith, states that due weight was given to schemes ontlined for the same during recent years by power companies and various individuals interested in the matter, and the accompanying map indicates what is coosidered to be the most suitable distribution system, and the one adopted for the purposes of this report.

In order to give proper regulation it was found necessary to select certain groups of power centres, as being independent of other groups, the transmission being distinct throughout the entire route from Niagara, except as regards right of way and telephone line, provision, however, being made, by interswitching stations at Hamilton and St. George, for interchanging loads, for night repairs between these points and Niagara Falls.

The groups decided upon are as follows:

Division I. Hamilton and Dundas.

Division II. Toronto, Milton, Brampton, Georgetown and Orangeville.

Division III. Brantford, St. George, Galt, Preston, Hespeler, Guelph, Berlin, Waterloo, Baden, New Hamburg, Tavistock, Stratford and St. Mary's.

Division IV. Paris, Woodstock, Ingersoll, Tilsonburg, London and St. Thomas.

Division V. Windsor, Walkerville, Wallaceburg, Dresden, Chatham, Thamesville, Bothwell, Glencoe, Strathroy, Alvinston, Oil Springs, Petrolia and Sarnia.

It is not considered, however, that Division V offers the same inducement as the other divisions, the small amount of power required at present and the great distance of transmission combining to make the cost of power at the municipal sub-stations rather high, and it is doubtful whether electric distribution in this division would be fully justified commercially at the present time.

DEMANDS FOR POWER.

In the personal canvass which was made, great care was taken to determine whether or not the consumer would be likely to adopt electric power if it were available, and a distinction was made in the case of those users who required steam for other purposes than that of power or who had refuse material as a source of fuel, and who, consequently, would not be apt to make a change in their source of power.

In estimating the total amounts of power to be distributed in each municipality, it has been assumed arbitrarily that, by the time transmission lines could in completed and with power for sale at reasonable figures, the total demand which should be provided for would be 25 per cent. greater than the estimated requirements at the present moment, and this has been the basis upon which the weight of copper has been calculated. In the transformer stations, however, separate estimates have been made for these total amounts as just mentioned, and also three-quarters

and one-half of the same, and all calculations leading up to the cost of delivered power at sub-stations have been made for these three conditions, always maintaining the full weight of copper in the transmission wires.

POWER REQUIREMENTS.

	Full Load.	¾ Load.	Half Load.
Division I	16,000 H.P.	12,000 H.P.	8,000 H.P.
" II	50,250 "	37,687 "	25,125 "
" II-A	3,106 "	2,329 "	1,553 "
" II-B	1,856 "	1,392 "	927 "
" III	19,040 "	14,280 "	9,520 "
" IV	12,458 "	9,345 "	6,229 "
" V	8,554 "	6,415 "	4,277 "
Totals	109,408 "	82,056 "	54,704 "

Note:—II-B is an alternative to II-A, and is not included in totals.

CONSUMPTION OF POWER.

The following table gives the present total consumption of all classes of power, the portion admitting of electric installation, and the probable future demand for electric power.

MUNICIPALITY.	Present total amount of power used. H.P.	Amount admitting of electric installation at present. H.P	Future demand for electric power. Full load being 25 per cent. increase on present demand. Full Load. H.P.	¾ Load. H.P.	Half Load. H.P.
		DIVISION I.			
Hamilton	17,640	12,320	15,400	11,550	7,700
Dundas	833	480	600	450	300
Total	18,473	12,800	16,000	12,000	8,000
		DIVISION II.			
*Toronto	53,362	40,200	50,250	37,688	25,125
		DIVISION II-A.			
Milton	500	430	537	403	268
Georgetown	1,450	720	900	675	450
Brampton	475	335	419	311	210
Orangeville	300	200	1,250	937	625
Total	2,725	1,685	3,106	2,329	1,553
Future demand for Orangeville based on supplying industries at present under construction.					
		DIVISION III.			
St. George	750	500	625	469	312
*Brantford	4,275	3,331	4,164	3,123	2,082
Galt	2,100	1,400	1,750	1,312	875
Preston	1,175	800	1,000	750	500
Hespeler	740	600	750	562	375
*Guelph	3,303	2,412	3,015	2,261	1,507
Berlin and Waterloo	3,800	3,150 {2200 950}	3,940	2,955	1,970
Baden	175	150	188	141	94
New Hamburg	380	200	250	187	125
Tavistock	365	275	344	258	172
*Stratford	2,430	2,012	2,515	1,886	1,257
St. Mary's	660	400	500	375	250
Total	20,153	15,230	19,040	14,280	9,520
		DIVISION IV.			
Paris	1,500	500	625	468	313
Woodstock	2,100	1,340	1,673	1,255	836
*Ingersoll	1,700	1,340	1,673	1,255	836
Tillsonburg	800	500	625	468	313
*London	6,500	4,690	5,862	4,399	2,931
St Thomas	2,400	1,600	2,000	1,500	1,000
Total	15,000	9,970	12,458	9,345	6,229
		DIVISION V.			
Strathroy	700	250	312	234	156
Alvinston	223	150	187	140	93
Oil Springs	585	400	500	375	250
Petrolia	1,303	600	750	562	375
Sarnia	2,680	700	875	656	487
Glencoe	200	140	175	131	87
Bothwell	325	200	250	187	125
Thamesville	166	140	187	140	93
Chatham	1,682	600	750	562	375
Dresden	460	175	224	168	112
Wallaceburg	960	475	594	445	297
Windsor	2,100	1,190	3,750	2,812	1,875
Walkerville	2,100	1,800			
Total	13,484	6,820	8,554	6,410	4,325

NOTE.—The figures for municipalities marked (*) were furnished by the Municipal Power Commission.

The only source of hydro-electric power requiring to be considered in this report, therefore, is the water of Lake Erie, utilized at the Niagara escarpment, which is feasible at various points extending from, and including, Niagara Falls westward some twenty miles. Further west than this the backbone between the escarpment and Lake Erie becomes too pronounced.

GENERATION OF POWER.

In dealing with this feature it has been studied from two points of view: First, the purchase of power; second, the construction of a new generating plant.

For the reasons that there are already three power companies partially or nearly completed on the Canadian side of the Niagara River, and a fourth company in operation near St. Catharines, and several other charters in existence on which considerable preliminary work has been done, and that transmission systems can be constructed in a shorter period of time than generating plants, and that the distribution of power will natually commence with a modest demand, and increase year by year, it is considered the better course of action would be for a Transmission Company to purchase its power, and all the calculations leading up to the cost of delivered power at municipal sub-stations have been based on an arbitrary price of $12.00 per 24-hour H.P. per annum at the high-tension bus-bars of the generating station, the price being determined upon a knowledge of recent sales of large blocks of power at Niagara. Should it, however, be considered advisable to construct a generating plant, which would take approximately four years to complete, the following estimate is made of the capital cost and annual charges—based upon the construction of a plant similar to those of the Electric Development Company of Ontario and the Canadian Niagara Company, but situated immediately above the intake of the Ontario Power Company. (See plan). Such a plant would have a tunnel tail-race about 5,000 feet long, and may be considered the cheapest and most suitable power site now available on the Canadain side of the Niagara River, the only others possible being either one between the Canadian Niagara Power Company's plant and that of the Electric Development Company, and which would not be looked upon favorably, as its supply of water is shut out by the latter works; or else at a site between the Canadian Niagara Power Company's plant and that of the International Railway Company. This site is out of the question for two reasons, because of the extreme shallowness of the Niagara river adjacent, and because the gradual recession of the Falls would soon completely ruin even its present impracticable position, and there would be no remedy available, as the construction of a wing dam at this point would completely put out of business the plant of the International Railway Company.

Should an additional electric power plant development be, for any reason, required, it need not necessarily be constructed at Niagara Falls. In fact there are

ESTIMATE OF GENERATING PLANT AT NIAGARA FALLS. (See Plan.)
CAPITAL COST.

ITEMS	50,000 H.P. Development.	75,000 H.P. Development.	100,000 H.P. Development.
	24-hour power capacity		
Tunnel tail-race	$1,250,000	$1,250,000	$1,250,000
Headworks and canal	450,000	450,000	450,000
Wheelpit	500,000	700,000	700,000
Power house	300,000	450,000	600,000
Hydraulic equipment	1,080,000	1,440,000	1,980,000
Electric equipment	760,000	910,000	1,400,000
Transformer station and equipment	350,000	525,000	700,000
Office building and machine shop	100,000	100,000	100,000
Miscellaneous	75,000	75,000	75,000
	4,865,000	5,900,000	7,255,000
Engineering and Contingencies 10 %	485,000	500,000	725,000
	5,350,000	6,400,000	7,980,000
Interest, 2 years at 4 %	430,500	520,584	651,168
Total capital cost	$5,780,500	$7,010,584	$8,631,168
Per horse power	$116	$94	$86

strong reasons why a plant located about 18 miles west of Niagara Falls would be a more favorable one, as the water can there be used under 300 feet head, requiring thereby only about one-half the amount of water, per H.P., which is used at Niagara Falls. The construction necessary would not disfigure the vicinity

of Niagara Falls, and as the power would be generated at a point 18 miles nearer the Canadian market, this advantage would accrue to the consumer by lessening the cost of transmission. Sufficient studies and estimates have been made to show that a development can be made at this point at a cost per H.P. not exceeding the cost of the Niagara developments.

The above estimate is based on the best class of construction in keeping with the surroundings; the machinery of the generating plant to be 10,000 H.P. units, with one spare machine in each case.

GENERATING PLANT. ESTIMATE OF YEARLY OPERATING CHARGES.

Items.	50,000 H.P. Development	75,000 H.P. Development	100,000 H.P. Development
Operating Expenses......	$ 57,900	$ 70,200	$ 86,300
Maintenance and Repairs.	115,700	140,400	172,600
Replacement Fund.......	86,800	105,300	129,500
Interest at 4 per cent.....	231,400	280,800	345,200
Rental of Water..........	52,500	65,000	77,500
Total yearly charges..	$544,300	$661,700	$811,100

In order to determine the cost per horse-power per year at the high-tension bus-bars of the transformer station, an allowance must be made for transforming losses.

The above estimate of yearly charges is based upon setting aside a sinking fund for replacements sufficient to renew various portions of the plant when worn out or obsolete. It has also been assumed that the rate of rental charged would be similar to that already in force in contracts between the Queen Victoria Niagara Falls Park Commissioners and existing power companies.

COST OF LOW TENSION POWER.

The following is the cost of low tension power at sub-stations (including sub-stations) and is based on an assumed rate of $12 per 24-hour horse-power per annum for high tension power at Niagara Falls:

DIVISION I, HAMILTON, ETC.

	Full Load.	¾ Load.	½ Load.
Total horse-power distributed	16,000	12,000	8,000
Total cost of power.........	$15.36	$15.59	$16.29

DIVISION II, TORONTO AND SUBURBS.

	Full Load.	¾ Load.	½ Load.
Total horse-power distributed	50,250	37,687	25,125
Total cost of power per H.P.	$16.53	$16.91	$17.15

DIVISION IIA, GEORGETOWN, ETC.

	Full Load.	¾ Load.	½ Load.
Total horse-power distributed..	3,106	2,329	1,553
Cost of 24-hour power:—			
Orangeville..................	$23.66	$25.90	$30.54
Brampton....................	21.23	22.45	25.37
Georgetown..................	20.14	21.18	23.70
Milton.......................	19.89	20.72	22.40

DIVISION IIB, GEORGETOWN, ETC.

	Full Load.	¾ Load.	½ Load.
Total horse-power distributed..	1,856	1,392	927
Cost of 24-hour power:—			
Brampton....................	$26.00	$28.84	$34.91
Georgetown..................	21.93	23.58	27.25
Milton.......................	20.92	22.11	24.36

DIVISION III, GUELPH, ETC.

	Full Load.	¾ Load.	1/2 Load.
Total horse-bower distributed	19,040	14,280	9,520
Cost of 24-hour power:—			
St. Marys..................	$25.86	$28.38	$34.20
Stratford..................	20.48	21.48	24.04
Tavistock..................	23.50	25.14	29.12
New Hamburg...............	22.34	23.37	26.08
Baden......................	23.91	25.08	28.06
Berlin and Waterloo.......	17.36	17.82	19.27
Guelph.....................	18.39	19.08	20.95
Hespeler...................	18.48	19.02	20.57
Preston....................	17.99	18.40	19.73
Galt........................	17.35	17.79	19.19
Brantford..................	16.87	17.29	18.48
St. George.................	17.14	17.54	18.62

DIVISION IV, LONDON, ETC.

	Full Load.	¾ Load.	1/2 Load.
Total horse-power distributed	12,458	9,345	6,229
Cost of 24-Hour Power:—			
St. Thomas..................	$21.89	$23.54	$27.21
London......................	19.51	20.52	23.03
Tilsonburg..................	24.30	26.67	31.86
Ingersoll....................	18.81	19.75	21.93
Woodstock..................	18.26	19.10	21.11
Paris........................	18.12	18.81	20.50

DIVISION V, WINDSOR, ETC.

	Full Load.	¾ Load.	½ Load.
Total horse-power distributed	8,554	6,415	4,277
Cost of 24-Hour Power:—			
Windsor and Walkerville.....	$27.13	$29.41	$35.47
Wallaceburg.................	30.74	34.01	42.02
Dresden.....................	30.87	33.74	40.79
Chatham.....................	24.62	25.95	30.15
Thamesville.................	27.83	29.65	34.43
Bothwell....................	25.45	27.02	31.11
Glencoe.....................	27.04	28.70	32.90
Sarnia.......................	29.28	32.55	39.91
Petrolia.....................	25.52	27.43	32.47
Oil Springs.................	26.00	27.99	33.28
Alvinston...................	27.64	29.48	34.19
Strathroy...................	27.82	30.48	36.83

COST OF DISTRIBUTION.

The following table shows the cost of distribution from municipal sub-station to an individual consumer, not covered by local distribution.

Distance in miles from Municipal substation	Cost per horse-power per annum for the delivery of various amounts of power.							
	50 HP	75 HP	100 HP	150 HP	200 HP	250 HP	300 HP	
2	$5 58	$4 20	$3 53	$2 92	$2 71	$2 60	$2.51	2,200 Volts
3	6 89	5 20	4 41	3 60	3 25	3 10	3 03	
4	7 92	6 18	5 20	4 27	3 93	3 72	3 86	
5	8 87	7 18	5 98	4 96	4 55	4 32	4.17	
6	10 20	8 21	6 77	5 38	5.13	4 60	4 43	
8	14 10	10 14	8 40	69 7	6 24	5 79	5 58	11,000 Volts
10	16 12	12 13	9 54	8 31	7 68	6 96	6 17	
12	18 76	14 03	11 12	10 12	8 42	7 96	7 22	16,500 Volts
15	22 74	17·08	13 48	10 89	9 35	8 84	8 32	

COSTS OF STEAM POWER PLANTS.

The table below shows capital costs of steam plants installed and annual costs of power per brake horse-power.

Size of Plant, H.P.	Capital Cost of Plant per H.P. Installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power Per B.H.P.
	Engines, Boilers, etc., installed.	Buildings.	Total.		
CLASS I.—Engines: Simple, slide-valve, non-condensing. Boilers: Return tubular.					
10	$66 00	$40 00	$106.00	$91.16	$180.76
20	56 00	37.00	93.00	76.31	151.48
30	48 70	35.00	83.70	66.46	131.68
40	44 75	33.50	78.25	59.49	117.74
50	43 00	31.00	74.00	53 95	106.46
CLASS II.—Engines: Simple, Corliss, non-condensing. Boilers: Return tubular.					
30	70.70	35.00	105.70	61.14	117.70
40	62 85	33.50	96.35	55 50	107.10
50	59.00	31.00	90 00	50 70	97.73
60	56.00	30.00	86 70	47 42	91.34
80	50 00	27.50	77.50	43.86	85.41
100	44 60	25.00	69.60	40.55	79.19
CLASS III.—Engines: Compound, Corliss, condensing. Boilers: Return tubular with reserve capacity.					
100	63.40	28.00	91.40	33.18	60 05
150	53 70	24.00	77 70	29 83	54.63
200	50 10	20.00	70.10	28 14	51.72
300	45 90	18 00	63 90	26 27	48.83
400	43 55	16.00	59.55	24 84	46.12
500	41 25	14.00	55.25	23.73	44.21
750	40 50	13 00	53.50	23.56	44.02
1000	39 00	12 00	51 00	23 26	43.71
CLASS IV—Engines: Compound, Corliss, condensing. Boilers: Water-tube, with reserve capacity.					
300	55 20	18 00	73 20	25 77	46 32
400	51 60	16 00	67 50	24.18	43 61
500	49 40	14 00	63 40	23 19	42 03
750	46 80	13 00	59 70	22.88	41.56
1000	41 30	12 00	56 80	22 47	41.11

NOTE.—Annual costs include interest at 5 per cent. depreciation and repairs on plant, oil and waste, labor and fuel (coal at $4 per ton). Brake horse power is the mechanical power at engine shaft.

In order to institute a comparison between the cost of electric power as has just been set forth and the cost of power generated by steam or producer gas, the following tables have been compiled after a careful study of data available in technical journals and also from data collected by the Commission's engineers in vari-

ous towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The tables represent average working conditions and assume a high class installation.

It will be noted that for a consumer requiring a large installation, operating for ten hours only, there appears to be little advantage to be derived from the use of transmitted electric power, provided the power is not to be distributed throughout a consumer's buildings by a complicated system of shafting, belts, etc. But in the majority of cases this condition obtains, and herein lies one of the specific advantages of electric power Motors can be installed on each floor of a factory, or even on each machine, with but little loss in efficiency, and only such motors as are required to drive the machinery in use from time to time need to be operated. In many cases due to this fact the total electric power consumption of a large factory would be reduced from 25 per cent. to 50 per cent. below that which is required under steam operation, working from a central station.

Again, where electric power is available throughout the 24 hours many industries will work night and day, thereby effecting a great economy, as is evidenced by a comparison of the cost of 24-hour steam or producer gas power with 24-hour electric power.

Perhaps the most striking advantage to be derived from the use of electric power as compared with other power is that the small consumer can obtain power at a rate which should not be appreciably greater than that made to the large consumer, although the present practice in selling electric power is to discriminate against the small consumer for the reason that electric power prices made by private companies are not based on cost of service, but are merely made with a view to displacing steam.

COSTS OF PRODUCER GAS POWER.

TABLE SHOWING CAPITAL COSTS OF PRODUCER GAS PLANTS INSTALLED AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Capital Cost of Plant per H P Installed			Annual Cost of 10-hour Power per B H P	Annual Cost of 24-hour Power per B H P
	Machinery, etc	Buildings.	Total		
10	$137 00	$40 00	$177 00	$53 48	$90 02
20	110 00	36 00	146 00	44 47	73 22
30	93 00	33 00	126 00	38 73	64 99
40	84 50	29 00	113 50	35 05	59 85
50	80 00	26 00	106 00	32 27	55 22
60	79 00	24 00	103 00	30 19	52 03
80	78 20	22 00	100 20	28 70	48 95
100	77 50	20 00	97 50	27 05	45 10
150	76 00	19 00	95 00	25 87	43 17
200	71 00	17 00	91 00	24 95	41 78
300	73 00	16 00	89 00	21 24	40 40
400	71 50	14 00	85 50	23 11	39 03
500	70 00	12 00	82 00	22 [illegible]	37 [illegible]
750	67 50	10 00	77 50	21 [illegible]	[illegible]
1000	65 00	8 00	73 00	20 16	34 [illegible]

NOTE : Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel. (Bituminous coal at $4.00 and Anthracite coal at $5.00 per ton).

A reference to the above table will show that the cost of power developed by producer-gas plants and gas engines is less than that produced by steam plants of the same capacity. It may be said, however, that up to the present no very large installations of suction producers have been made, 250 to 300 horse-power being about the maximum. But this has been provided for in the table by assuming that the larger plants will be made up of several units, each unit being not greater than 350 H. P. capacity. While operation of producer-gas plants has not been going on many years, and complete knowledge on the subject is not available, with the information at hand it is believed that in many situations this form of power producer will be found more economical than a steam plant, and therefore a closer competitor of hydro-electric power. It must be remembered that the same objections hold against the producer-gas plant as those which have been mentioned in reference to steam plants, namely, that 24-hour power costs proportionately more than 10-hour power ; that the small consumer does not have the great advantage obtainable by the use of electric power ; and also that a central installation in a factory is all that is possible if electric motors are required in various parts of the factory, and the only prime mover available is steam or gas. This will make the cost of electric factory operation very expensive, and considerably higher than the power costs shown in the table. Speaking generally, however, it may be said that producer-gas plants have a bright future, and as the design and construction is perfected undoubtedly the capital cost will be reduced and the cost of power lessened.

COSTS OF POWER.

In a paper entitled "The Coming Power" in the Electrical Review, Mr. E.R. Knowles gives the following comparative commercial costs of power from various sources :

COMPARATIVE COSTS OF POWER PER BRAKE HORSE-POWER YEAR.

Engine	Fuel	Price	Fuel Consumed per B H P per Hour.	Fuel Cost per B H P Hour	Fuel Cost per B H. P Year
Gas	Producer gas	Anthracite pea coal $3 per ton	1¼ pounds	$0 001875	$18.00
Gas	Natural gas	25 cts per 1,000 ft	15 cubic feet	0 00375	16 25
Gas	Crude oil	[illegible] cts per gallon	1 10 gallon	0 004	16 00
Gas	Gasoline	12 cts per gallon	1 10 gallon	0 012	40 00
Corliss condensing	Coal (Bitum)	$3 per ton	3 pounds	0 0045	43 50
Turbine condensing	Coal (Bitum)	$3 per ton	3 pounds	0 0055	43 50
Gas	Illuminating	90 cts per 1,000 ft	18 cubic feet	0 018	58 00
Slide valve simple	Coal (Bitum)	$3 per 1,000 ft	8 pounds	0 012	66 00
Electric current (central station)		3 cts per kw hour		0 0225	71 00
Hydraulic		...			$90.00

In conclusion Mr. Knowles says : "While the ga engine producer system is still far from the desired ideal system, nevertheless the great gains in efficiency and lowering of cost production shown by this system and its many advantages are such that with its advent the gas engine has made such rapid strides as a prime mover, and its adoption to power generation has given so much satisfaction not only from an economical point of view, but also for continuous and hard service, that it bids fair to revolutionize all present methods of power production and to become the legitimate successor of the steam engine and steam system."

THE CANADIAN GENERAL ELECTRIC COMPANY.

The annual meeting of the Canadian General Electric Company was held in Toronto recently. The statement presented showed profits for the past year of $608,206, an increase over the previous year of $25,687.

The report says: "Many new lines of manufacture have been undertaken, and the development expenses necessitated thereby have been charged straight to expense account, rather than to spread the development charges over a period of several years, as might fairly have been done, and this policy is considered by your directors as preferable to adding this year to reserve fund from unexpended profits."

BREAKDOWNS OF ELECTRICAL MACHINERY

It has frequently been said that failures are more instructive than successes, and if the saying be a true one, the annual report of the Chief Engineer of the British Engine, Boiler & Electrical Insurance Company should be instructive in a high degree, for it contains numerous descriptions of breakdowns and other troubles in electrical machines and steam, gas and oil engines. The business of this company is the insurance of engines, boilers, dynamos and motors against damage from breakdown, explosion or collapse, as the case may be.

The last report issued covers the year 1904. Referring to the insurance and inspection of electrical machinery, it is stated that the increase in this department of the company's business was satisfactory. The number of dynamos and motors insured at the end of 1904 exceeded the number insured at the end of 1903 by 20 per cent. On the other hand, it is recorded that the number of breakdowns of insured machines in 1904 exceeded the number in 1903 by 28 per cent. The claims made, therefore, increased more rapidly than the insurances effected. The cause of this increase is not apparent, unless it be deterioration resulting from greater age. The rate of breakdown among dynamos was one in twelve, the rate among motors one in 9.3, excluding breakdowns of starting resistance switches, or one in 8.2 including them. The ratios in which the different parts of the damaged dynamos and motors are thought to have contributed to the total are :

	Dynamos.	Motors.
Armatures and rotors......	55 per cent.	47 per cent.
Magnets and stators.......	7 "	11 "
Commutators and brush gear	28 "	18 "
Miscellaneous.............	10 "	8 "
Switches and resistances...	"	16 "
	100	100

The causes of the damages may be classified as under:—

	Dynamos.	Motors.
Accidents............	9 per cent.	9 per cent.
Dirt and neglect..........	13 "	19 "
Age and deterioration....	38 "	25 "
Bad workmanship and design..................	20 "	16 "
Overloading....	3 "	3 "
Causes not ascertained...	17 "	28 "
	100	100

The nature of these breakdowns may be gathered from the following brief descriptions, more than half of which relate to breakdowns due to defective workmanship or design, because these breakdowns more often teach useful lessons than those resulting from any of the other causes mentioned:—

1.—Small bi-polar series-wound motor, coupled direct to the spindle of a 42 in. Blackman ventilating fan. The Inspector found the fuse melted and the ends of the copper brushes rough and opened. Evidently the damage to the brushes had been caused by the motor running backwards through the action of the wind upon the fan, for the previous day, a Sunday, had been very stormy, and the storm doors at the end of the outlet duct had inadvertently been left open. The fuse doubtless melted when the attendant tried to start the motor, while the commutator was jammed by the disordered brushes. The Inspector trimmed and reset the brushes, and left the fan running satisfactorily. The accident is one of many due to the same cause, and suggests the use of carbon brushes and of self-acting shutters on the outlet ducts of motor-driven fans.

2.—Four-pole shunt-wound 5 H. P. motor, taking current from a 3-wire Corporation supply at 460 volts, with the middle wire earthed. Shortly before stopping one evening the fuse melted. Another fuse was put in which also melted. After much fruitless search for the fault the cover over the main terminal block on the frame of the motor was removed, and a mouse's nest and a partly cremated mouse were found inside. The mouse was lying in such a position that it must have touched one of the terminals and the metal cover simultaneously, and thus received a shock of 230 volts, the cover being in contact with the frame, which was earthed in accordance with the Corporation rules. The mouse had evidently been in the habit of coming home after working hours and going out before the motor started.

3.—Four-pole centre-hung shunt-wound motor, rated to take 45.5 amperes at 460 volts. Speed 625 revolutions per minute.

At one of his periodical visits, the Inspector found the motor had been stopped on account of sparking, excessive heating of the armature, and falling out of the automatic overload release which was set at 70 amperes. Seeing no defect about the machine externally, he attempted to run it, but found that although the speed was practically normal the current taken was so excessive that the automatic release fell out as stated, and finally the fuse, consisting of eight No. 30 S.W.G. copper wires, melted. Having convinced himself that the motor could not run, he made a more minute examination, and finally discovered a bad contact between the negative supply cable and the main terminal on the machine due to slackness of the terminal nut. He tightened the nut and started the motor again, when it ran quite satisfactorily. The trouble was due to the fact that one end of the shunt circuit, as well as the negative brush lead, was connected to the terminal with which the negative supply cable was making faulty contact. Although at first sight it is not obvious why a resistance introduced into the main circuit of a motor should increase the current taken and not affect the speed, yet a little consideration will show that it must be so. For, whilst the voltage across the armature is reduced, tending to reduce the speed, the shunt current is also reduced in the same proportion, weakening the field and tending to increase the speed. The two effects nullifying each other, the speed remains unaltered, but that the motor may continue to drive its load the current must be increased to make up for the reduction of the voltage through the resistance of the faulty contact.

Judging from the melting current of the fuse, about 100 amperes, the voltage must have been reduced by about 50 per cent. A loose contact on a fuse terminal on a motor circuit will produce the same result, and the melting of fuses attributed to the heat generated by imperfect contacts is in many cases due partly to

the passage of excessive currents caused in the way described.

4.—Shunt-wound 4 B.H.P. partly-inclosed motor, taking current at 230 volts. On receiving notice that the motor had broken down, an Inspector was sent to examine it. He found it at work, but sparking so much that he asked the owner to stop it for examination. On taking off the side doors he found it in a filthy condition, the commutator black and rough, and the brush holders covered with oil and dust to such an extent that the ends of the brush holder spindles, nuts, and insulating washers were completely hidden by the thick coating of dirt. The armature also was oily and dirty, and the flanges of the bushes in the bearings worn almost through, allowing the shaft an endlong motion of ½in. Nothing, however, was broken. The Inspector thoroughly cleaned the commutator and brush gear, and left the motor running without sparking. The motor was suspended from the ceiling, and inaccessible without a ladder. Its neglected condition was no doubt due to its position.

5.—Completely-inclosed shunt-wound 38 B.H.P. motor, taking current at 420 volts, and used for driving an ore-cutting machine in an iron ore mine. On receipt of a telegram, "Motor stopped, armature firing," an Inspector was sent to ascertain the extent of the damage. On arrival at the mine he was informed that the attendant having seen sparks through the window in the commutator end of the casing, had stopped the motor. On examination, he found that the sparks were the result of partial short circuits established between the spokes of the commutator by iron dust, which had been drawn in by the draught created by the armature. With some iron wire and a pair of bellows borrowed from a neighboring cottage, he scraped and blew out the dust, much to the discomfort of the miners. The motor was then restarted, and worked all right. As the casing of the motor was, as far as could be seen, quite air-tight, it seems probable that it must have been left off at some time, or that the dust must have dropped off the attendants' clothes when adjusting the brushes. At the Inspector's suggestion, a canvass cover was fixed over the open spokes of the commutator to prevent as far as possible the dust getting in between them. This has so far proved successful, and the makers of the motors have decided in future to arrange the commutator spokes of all machines for use in similar situations to form a solid face in front of the aramature windings.

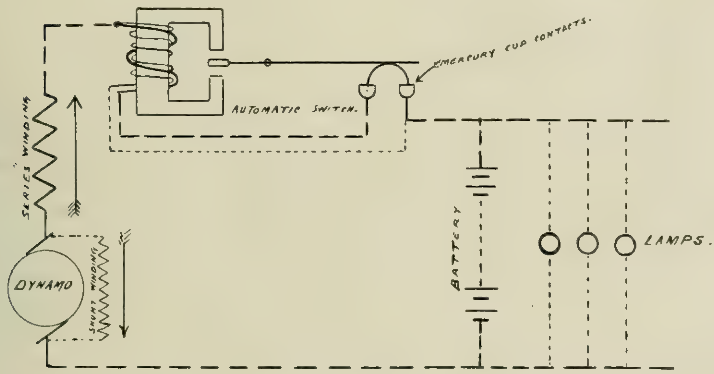


Fig. 1.—Breakdowns of Electrical Machinery.

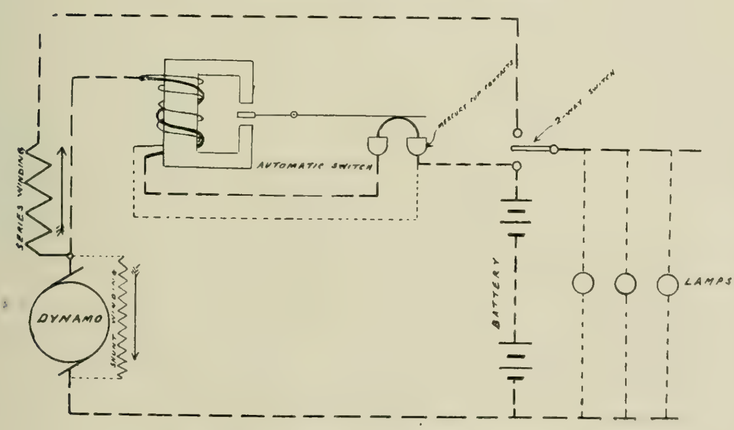


Fig. 1a.—Breakdowns of Electrical Machinery.

In another case, an inclosed motor working in a place where hard dry wood was sawn, was subject to occasional explosions of a mild kind. The Inspector who examined it attributed them to rapid combustion of fine wood dust ignited by sparks from the brushes. These cases prove the necessity for cleaning even completely-inclosed motors periodically.

6. —Completely-inclosed 4 B.H.P. Lundell motor, taking current at 250 volts. The motor broke down. When opened, the lower part of the field coil was found to be saturated with oil and partly burnt out. The oil had run down from the bearings and accumulated in the bottom of the casing, which was, as usual, unprovided with a drain. This is but one of the many similar cases which prove the necessity of making provision for draining the casings of all protected and inclosed machines in whatever position they are fixed.

7.—Four-pole shunt wound motor, running at 1,500 revelutions per minute, and taking 12½ amperes at 230 volts, controlled by a main switch and a starting resistance switch fitted with automatic no-load and overload release coils. The Inspector was informed that the motor could not be started because the fuse melted whenever the main switch was put in. A glance at the position of the lever of the starting switch showed that the resistance was cut out of circuit, and the mains short-circuited by the motor armature. The lever was fitted with a coil spring, but had become so

stiff from neglect that the spring had not sufficient force to throw it back when released by the no-load coil. It consequently remained in the position in which it had been left the last time it had been used for cutting out the resistance coils of the starting switch. A little cleaning and a drop of oil applied by the Inspector put matters right.

8.—Compound-wound dynamo, giving 635 amperes at 110 volts when running at 500 revolutions per minute. Owing to failure of the insulation between two of the armature conductors an arc was set up which burnt a hole 2½in. diameter through the windings and down into the core. The core was not a

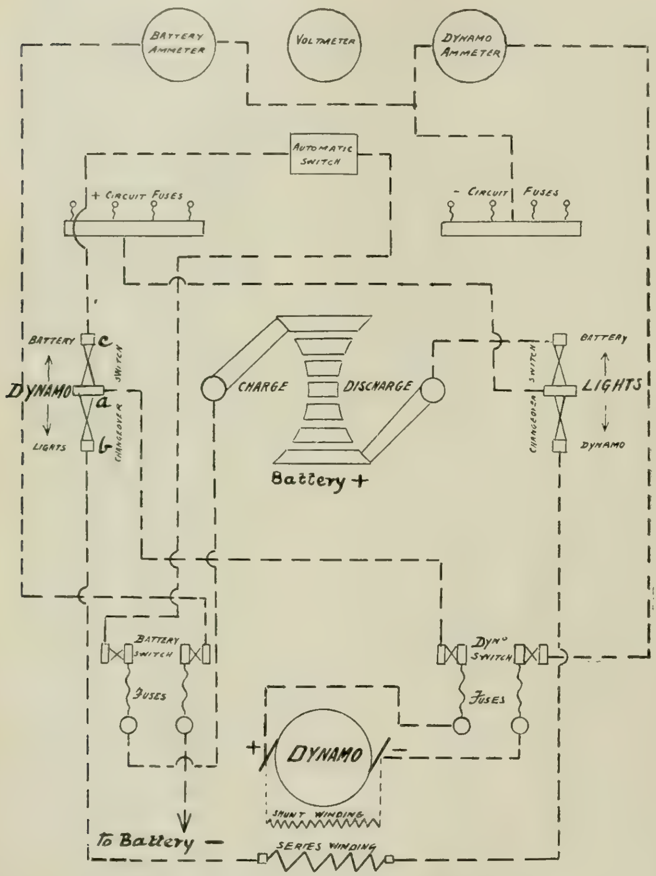


Fig. 2.—Breakdowns of Electrical Machinery.

slotted core, as the term is generally understood, carrying all the conductors in slots below the surface, but was provided with a certain number of longitudinal grooves in which some of the conductors were tightly fixed. These conductors being deeper than the grooves, es, projected above the circumference of the core, and formed driving bars for the others which were laid upon the smooth surfaces between them. Breakdowns of armatures of this design are not infrequent, and the arrangement is not to be recommended, for it is difficult to hold the winding absolutely immovable, and the slightest movement soon grinds away the insulation.

9.—Four-pole 25 kw. dynamo, generating at 240 volts when running at 900 revolutions per minute. The Inspector found the brushes sparking and the commutator worn flat at two diametrically opposite places. The attendant stated that the machine had been sparking for some time, and that he had noticed the flat places, but was unable to account for them. The Inspector found signs of heating and imperfect contact at the joints of the armature conductors to the spokes of the flattened commutator bars, and advised a thorough cleaning and resoldering of the joints. This was done, and the sparking and wear of the commutator ceased.

10.—Six-pole shunt-wound dynamo, of continental make, giving 420 amperes at 240 volts when running at 400 revolutions per minute. On receipt of notice of a breakdown an Inspector was sent to give instructions for the necessary repairs. He found one of the armature conductors disjointed from the commutator through melting of the solder. Not being satisfied as to the cause he had the steel wire binder next to the commutator removed, and then found the space inside the conductors between the end of the armature core and the commutator filled with dirt and solder, some of the pieces being so large that a second steel binder had to be stripped off before they could be got out. In all about half a pound of solder was removed after three hours' work. It is difficult to see how the solder got inside the armature, except on the supposition that the conductors had been laid in their respective slots in the commutator spokes and secured by the steel binders, and that the armature had then been placed on end, and the connections soldered; but it is still more difficult to understand how the machine could have run with the commutator arms so frequently short circuited, as they must have been, by the loose pieces of solder coming into contact with them.

11.—Twelve-pole direct-driven dynamo, giving 1,200 amperes at 235 volts when running at 160 revolutions per minute. The machine was of continental make, and erected by the makers' men, but had proved unsatisfactory owing to heating of the commutator and violent sparking. One of the Inspectors was asked to examine it, and try to find a remedy for the trouble. On testing between the segments of the commutator he found four in parallel, but the brushes only covering two and a half. The commutator was 48 in. diameter, and there were 12 brush spindles, each carrying 10 carbon brushes 0.98 in. wide and 0.59 in. thick. He was told that the brushes on each spindle instead of being in line had originally been staggered, each alternate brush being a little in advance of its neighbor, so that the brushes then covered three segments. This arrangement hav-

ing proved unsatisfactory, new brush holders had been supplied with brushes covering 2½ segments, and finally an expert from the makers had come over and fitted new brushes, again covering 2½ segments only. The Inspector could not ascertain the reason for this arrangement, but having ascertained that there were four bars in parallel, he could not see how the brushes n use could short circuit consecutive coils, and allow time for commutation. He therefore suggested trying new brushes wide enough to cover 4½ segments on

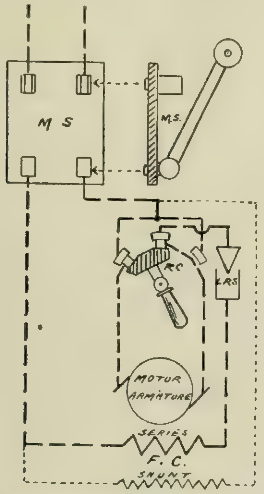


FIG. 3—BREAKDOWNS OF ELECTRICAL MACHINERY.
MS = Main Switch (front and side view).
RC = Reversing Controller.
FC = Field Coils.
LRS = Liquid Resisting Starter.

two of the brush holders. The alteration being successful, the remaining brushes were altered, and the machine has run satisfactorily since. The reason for setting the brushes to cover 2½ segments only has not been ascertained.

12.—Compound-wound 2-pole dynamo, giving 40 amperes at 100 volts at 1,180 revolutions per minute. The Inspector found the owner preparing to take out the armature for the purpose of sending it to the works of a firm in the neighborhood who had informed him that it would have to be stripped and rewound. Fortunately, the Inspector arrived in time to stop the work, for the trouble was entirely due to short circuits between the commutator segments caused by an unskilful attempt to turn up the surface with a blunt tool, which had dragged the copper over the mica insulating strips. After filing down the roughest places, picking the copper out of the mica, and smoothing the surface with sandpaper, the Inspector started the machine and left it running satisfactorily.

13.—Series wound 8 H.P. motor, taking current at 200 volts, and connected by a coupling on the end of the armature spindle to the hoisting motion of a crane. The armature shaft broke off at the shoulder against which the coupling abutted. The shoulder was quite square to the shaft. The fracture started in the square corner all round the circumference, and gradually ate its way inwards till the sound core became insufficient to bear the stress upon it. The weakening effect of abrupt changes of section and sharp notches in shafts is duly appreciated by most makers of steam engines, but makers of dynamos and electric motors seem quite indifferent to it; yet considering the enormous number of alternations of stress in a given time on the shafts of these machines one would think that every possible device would be resorted to to minimize their effect. Considering that these small shafts often make from three to four million revolutions per week of 56 hours, it is wonderful that they live so long as they do.

14.—Four-pole inclosed shunt-wound 20 B. H. P. motor, taking current at 110 volts and running at 560 revolutions per minute. The commutator consisting of 110 segments 9 in. long was built upon a cast-iron quill or sleeve, and secured at one end by a collar on the quill and at the other by a clamping ring. This ring was fastened to the cast-iron quill by six steel screws ⅜ in. diameter, with cheese heads recessed into countersunk holes on the face of the clamping ring and screwed into the end of the quill parallel to the motor shaft. The commutator segments got loose and began to rise, and on examination the six screws which held the clamping ring were found to be broken between the heads and the parts which were screwed into the quill. As the screws were tightened with a screw-driver it is inconceivable that they could have been broken by excessive force applied by the workman, and the suggestion is made that they were broken by the stress caused by the expansion of the copper segments due to heat. This suggestion is not so far fetched as may at first sight appear.

The expansion of the copper bars 9 in. long would be .00009 in. per degree Fah., rise of temperature, while the expansion of the cast-iron quill would only be .000054 in. Suppose when working the tempera-

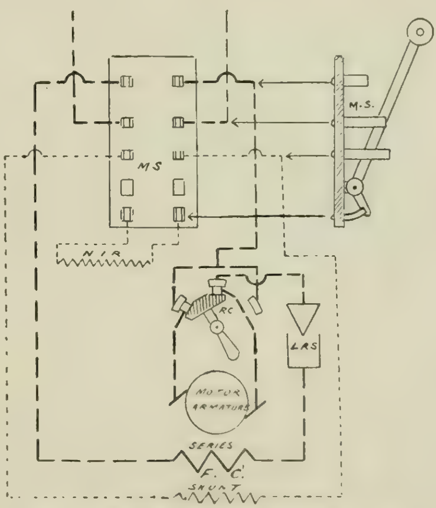


FIG. 4 BREAKDOWNS OF ELECTRICAL MACHINERY.
MS Main Switch (front and side view).
RC Reversing Controller.
FC Field Coils.
LRS Liquid Resisting Starter.
NIR Non-inductive Resistance.

ture of the copper rose 50°, and that of the iron 20° above the temperatures at which the commutator was put together, then the difference in the expansion of the two would be $.00009 \times 50 - (.000054 \times 20) = .0033$ in., and this would be the amount by which the screws and the quill would have to stretch. Supposing the whole of the stretching to take place between the heads of the bolts and the end of the quill, that is, in the parts which passed through the clamping ring,

a length of about ½ in., then, with a modulus of elasticity of 30,000,000 lbs. per square inch the stress on the bolts would be 30,000,000 × .0033 ÷ 0.5 = 198,000 lbs. per square inch. Of course, the actual stress was not so great, because the quill notwithstanding its enormously greater cross-sectional area must have stretched to some extent as well as the bolts, while the insulating material between the ends of the copper bars and the collar and clamping ring which held them must have been to some extent compressed. Still the rough calculation indicates the magnitude of the stresses set up by even a small amount of expansion when it has been taken up by a short piece of material.

15.—Compound-wound six-pole dynamo, giving 125 amperes at 200 volts when running at 575 revolutions per minute, used for lighting a spinning mill in the morning and evening, and for charging a battery in the owner's house during daylight. One day on switching the dynamo on to the battery the fuses melted. The Inspector who attended to ascertain the cause found the polarity of the dynamo field reversed, so that when switched on to the battery the armature was in circuit with it, thus short circuiting the system. The arrangement of the connections is indicated by Fig. 1, which shows that current from the battery to the dynamo passed through the series coils in the opposite direction to current from the dynamo to the battery, and therefore tended to reverse the polarity of the field, and did reverse it when the ampere turns in the series exceeded those in the shunt. The next diagram, Fig. 1a, shows the alteration suggested by the Inspector to prevent a repetition of the accident.

The Inspector was unable to find out how the direction of the series current became reversed. It might have happened in many ways—for instance, the automatic switch may have stuck and failed to fall out on the opening of the battery main switch, in which case the battery would be short circuited on putting in this switch again for charging. The automatic switch would then, indeed, fall out or the fuse would melt, but in the meantime the polarity of the magnet would have been reversed. Again, the attendant may have put in the automatic switch by hand, without thinking what he was doing, before starting the dynamo. In fact, so many accidents may occur that it may be taken as an axiom of good practice that the series windings of compound machines should ever be in circuit with a battery.

As the company has had several similar cases to deal with, and as the correspondence to which they have given rise shows clearly that the danger is not generally understood, it may be well to explain how it may be avoided.

One of the most common devices is the insertion of a short-circuiting plug to cut out the series windings; but this is unsatisfactory, because the plug may be forgotten, or the presence of a little dirt on the plug or socket may prevent effective contact. The arrangement recommended by the Company is shown by the diagram, Fig. 2, from which it will be seen that it is impossible to place the series windings of the dynamo in circuit with the battery, because the change-over dynamo switch cannot connect *a* with the contacts *c* and *b* at the same time. It is also clear that the lighting circuits cannot receive current direct from the dynamo when the latter is running at the higher voltage required for charging the battery.

16.—Compound-wound 20 B.H.P. motor, proposed for insurance. The motor belonged to a jib crane, and was supplied with current at 500 volts through a double pole main switch, a liquid resistance starting switch, and a controller for reversing. The shunt coil was connected across the mains, as indicated in the diagram Fig. 3, so that the shunt circuit was broken whenever the main switch was opened, and the insulation strained, and finally broken down, by the high voltage resulting from the induction of the shunt circuit. Various methods of connecting the shunt coils of motors having wire resistances in the starting switches to prevent breakage of the shunt circuits were explained in detail in the Annual Report for 1899, and the necessity for adopting one or other of them seems to be more generally admitted than it was five years ago. These methods, however, are not always easily adapted to motors controlled by liquid starting switches, and the problem is still further complicated by the introduction of a reversing controller. Therefore it often happens, as in this case, that it is not possible to arrange the connections so that the shunt circuit may always remain closed on the motor armature, and some other device is necessary to "damp down" the inductive effect which the breaking of the shunt produces. This device consists in putting a non-inductive resistance in parallel with the shunt, of sufficiently low resistance to prevent a dangerous rise in voltage when the circuit through the shunt is broken. Sometimes a bank of lamps is placed permanently in parallel with the shunt, but this arrangement is somewhat wasteful. A better plan is to use some special form of main switch like that shown in the diagram, Fig. 4, which will throw the non-inductive resistance into parallel with the shunt just before the main circuit is broken. The arrangement has also the advantage of first disconnecting everything except the shunt circuit, so that the armature and other parts, which are seldom as well insulated as the magnet coils, are not exposed to the rise in voltage which even the introduction of the non-inductive resistance does not entirely prevent.

17.—Series-wound 2-pole 30 B.H.P. motor, taking current at 400 volts. The armature core was carried on a gun-metal spider with three arms threaded upon a steel shaft 3 in. diameter with a feather key and secured against a collar at one end and by a nut 1¼ in. thick and 3¾ in. over the flats at the other. The commutator segments were carried on a gun-metal quill having a collar at one end and a nut at the other in the usual way. The quill was held against a shoulder on the armature shaft by a nut at the outer end and prevented from turning partly by the friction of the nut and partly by an iron peg 3/16 in. diameter stuck into a radial hole in the shaft and projecting 3/16 in. above the surface to engage in a short keyway cut in the inside of the quill. Owing to low insulation, the commutator was taken off in order to test the armature conductors, when the peg above referred to was found partially sheared through, the nut for securing the armatere spider off the screwed part of the shaft, and hanging loose upon the plain part between the end of the screwed thread and the commutator quill, also the keyway in the spider worn ¼ in. wider than the key. Both armature and commutator being loose upon the shaft, breakage of the end connections and destruction of the insulation by rubbing might be expected.

Attention is drawn to this case because it is typical of so many others, and to emphasize the necessity for first-class workmanship in the fitting of spiders, cores, and keys in dynamo construction. If shrinking or forcing by hydraulic pressure is not to be resorted to, nothing but the most accurate fitting will insure durability, Another point to be insisted on is the advantage of fitting both the armature core and the commutator on one sleeve, so as to reduce the risk of relative movement to a minimum.

THE ELECTRICAL DEVELOPMENT COMPANY.

One hundred prominent business men of Toronto accepted the invitation of the directors of the Ontario Development Company of Ontario to visit Niagara Falls on the 8th inst. and witness the laying by the Lieutenant-Governor of Ontario of the corner stone of the Company's new power house now in course of construction.

The party was conveyed to the Falls by special train under the direction of the President, Sir Henry Pellatt; the Managing Director, Mr. Frederic Nicholls, and the Secretary, Mr. Harry Nicholls, and spent an interesting day in inspecting the various features of this important undertaking, on which about $8,000,000 has already been expended.

The laying of the corner stone of the building by the Lieutenant-Governor was followed by the laying of two other foundation stones by the President and Managing Director respectively, after which the visitors were entertained at luncheon, when the Directors were heartily congratulated upon the success of their great enterprise, regret being expressed, however, that the Ontario Government should have adopted legislation calculated to cause the withholding of capital from undertakings of this character and to injure the large investments already made.

Further particulars of the progress of this great undertaking is withheld pending the publication of our June number, in which it is proposed to publish more detailed description of the works under construction for the utilization of the great water power at Niagara Falls.

Laying the Corner Stone of the Electrical Development Company's Power House, Niagara Falls, Ont., May 8th, 1906.

APPROACHING CONVENTIONS.

American Institute of Electrical Engineers, Milwaukee, Wis., May 28 to June 1.

National Electric Light Association, Atlantic City, N. J., June 5, 6 and 7.

Canadian Electrical Association, Niagara Falls, Ont., June 19, 20 and 21.

American Boiler Manufacturers' Association, Pittsburgh, Pa., September 18, 19 and 20.

A SHORT-SIGHTED POLICY.

Ottawa, May 7th, 1906.

Editor Canadian Electrical News:

Dear Sir,—Leading architects and electrical contractors are much incensed at the action of the city in withdrawing from the agreement with the Ottawa Electric Company to uphold the Underwriters in the inspection of this city. It is a short-sighted policy and not much credit to the city. Nearly every city in America and Europe have an inspector who is maintained by a system of fees and it is a recognized custom practically over the civilized work.

The Canadian Fire Underwriters' Association sent their chief electrician to Ottawa last year and agreed to appoint a man if the city and the company would withhold meters until certificate of inspection was produced. This was agreed to by both parties and the city agreed to contribute a small sum, something less than $100 per year, and the company likewise; the Underwriters to find the balance required. This was agreed to and the Underwriters appointed Mr. Berlstienger on a salary and furnished all other expenses and charged the customary nominal fee, which only pays a very small portion of the cost. The city have evidently listened to a lot of petty objectors and have withdrawn, so that unless strong objection is made by representative architects and contractors Ottawa bids well to slide back to its original state of chaos and will some day mourn a conflagration again or have their insurance rates "boosted" owing to the lack of protection. If the city won't pay for an inspector they might at least assist the Underwriters in maintaining an already much needed and well started inspection bureau.

This is a duty devolving upon a city and especially on lighting companies, and it is up to the trade to "kick" vigorously against such a display of ignorance and short-sightedness on the part of someone.

Yours truly,

Electrician.

[Does it not seem that it would be in the interests of the Underwriters to employ an inspector for a city the size of Ottawa? An expenditure of, say, one thousand dollars a year for salary would be infinitesimal if the risk of fires resulting from bad wiring is great. Would not the situation be improved by employing such an inspector and doing away with fees altogether?—The Editor.]

CANADIAN

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AND ENGINEERING JOURNAL

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SUBSCRIPTIONS.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Electrical Growth.

This number of the ELECTRICAL NEWS consists of fifty-two pages, which will be the size of all regular editions in future until another enlargement becomes advisable. So great has been the growth of the electrical business in Canada that increased space was needed to describe the many interesting plants and record the progress of the industry generally. The growth of this journal will be dependent upon the advancement of electricity, which promises to be very marked in the next few years, and we predict that another increase in size will shortly become necessary. It has always been our aim to confine the contents of the ELECTRICAL NEWS to the special field which it represents. We want to make the paper peculiarly interesting and instructive to persons engaged in all branches of the electrical business, and to that end we invite suggestions as to how we may improve it. Contributions on electrical subjects, or descriptions of new apparatus and methods of installation and operation, will always be appreciated.

Depreciation in Electrical Apparatus.

Elsewhere we print abstracts from the report of the British Engine, Boiler and Electrical Insurance Company, of Manchester, England, and facts are presented therein which call for comment. We are at a loss to understand such a large percentage of breakdowns, and sufficient information is not given to enable us to intelligently solve the question. It may be that the percentage is based on the number of cases of reported trouble, and has no relation to the pecuniary loss to the company. It is apparent that the company's inspector is called for a blown fuse, and if such is considered a breakdown we can understand the large number of so-called accidents. While not being as familiar with the class of machines used in England as those employed on this Continent, we would be inclined to think that the machines insured were those of a low grade of manufacture, and under such circumstances the frequency of breakdown may to a certain extent be explained. If such is the case, the cost of insurance to the insured must be higher, and doubtless the company, while not desiring such risks, is willing to take the hazard at a proportional premium. The whole question is one of decided interest, and though the report does not give much information of value, still in it we have a nucleus of engineering data which may some day prove of value. If the American Institute of Electrical Engineers should investigate the question of breakdowns, on the same basis as they have gone into the lightning problem, the data would be more comprehensive, and from it could be taken a typical rate of failure. Under such circumstances, blown fuses would not be considered as very serious accidents, and cases where mice built nests in motor frames would doubtless be excluded.

The Hydro-Electric Report.

Elsewhere we publish extracts from the report of the Hydro-Electric Commission, dealing with the cost of power delivered from Niagara Falls to the various Municipalities in the southern part of Ontario. This is the first report which has come to us from the Commission, and it deals only with that section of territory which, for convenience, has been

named the "Niagara District," and which, according to the plans of the Commission, could be supplied from the waters of Niagara Falls. The Engineer of the Commission has handled this matter in a very able way, and while we are inclined to think that he is rather optimistic when dealing with operating costs, nevertheless we consider that the data given in the report is of considerable value, and that it throws appreciated light on the subjects about which much doubt has existed in the past. The report points out that so far as the Municipalities are concerned, it might be a wise move to erect transmission lines to Niagara Falls and purchase power from the companies which are in operation there at the present time, or shortly will be in operation. In the event of its being found impossible to make satisfactory arrangements with the existing companies, the report proposes the erection of a fourth power house on the Canadian side, adopting a scheme of development very similar to that which has been employed by the company which will furnish power to Toronto. The Engineer also points out that there is a location some twelve or thirteen miles west of Niagara Falls which could be developed at a cost per horse power not exceeding the proposed Niagara plant, and he draws attention to the fact that at this western site the available head would be approximately three hundred feet, instead of one hundred and forty, which is the average now in use at the Falls proper. The report has created considerable interest, and while we appreciate the effort which has been expended in collecting the data, we regret that it is necessary to anticipate a repetition of the slow but sure death experienced by the municipal document.

Inspection. In the last few numbers of this paper, comment has appeared upon various pages which can be generally characterized as applying to questions of good wiring. While there seems to be no immediate hope of a satisfactory solution of the difficulties which have confronted engineers for many years past, still the necessity for some radical and concerted action is decidedly apparent. When we discussed in these columns the subject of electric fires, we pointed out the lamentable habit of the general public of attributing all fires of unknown cause to electric wiring. We are quite willing to admit our share of liability, but on the other hand, some slight protest can be expected where every unknown fire is charged against the electrical fraternity. Where fires of electrical origin actually do occur, we usually find that, as one of our correspondents stated, the work has been done by amateurs, firemen, carpenters, etcetera. The suggestion of licensing wiremen is an exceedingly good one, but in combination with such a license system an inspection bureau should be maintained which would be efficient in every sense of the word. The maintenance of this bureau is really of little importance, so long as the work of such department is carried out in a systematic, thorough, and effective way. Generally speaking, we are inclined to think that the cost of such a department should be borne equally by the City and by the Underwriters, and that this department should also have the power of granting first and second class licenses to wiremen. General licenses could be granted to contractors, under which license they would agree to employ licensed wiremen only. Then, after a job had been completed, an inspector of the department would be called upon to examine the work, and should he find things in bad shape, the guilty party could be located at once, and a lost certificate should result. Such a system of inspection and license would be fair to all conscientious contractors who desire to turn out nothing but first-class work, and who make a practice of using first class material. These men are to-day frequently under-bid by a miscellaneous collection of little men who take jobs at any price, and who do work in the very cheapest possible way, using in many cases material which the Underwriters would absolutely refuse to accept, and relying on the hidden condition of this material to pass inspection.

The use of iron conduit is unquestionably safer in some localities than the old style open wiring, but it does not follow from this that its use is advantageous under every condition. When Mr. Ross spoke of this matter in Montreal he undoubtedly had this fact in view, and he supported his opinion by his own personal experience. A conduit system, to be safe, must be installed in same conscientious manner which makes open wiring safe, and what trouble has arisen may doubtless be charged to the little contractors who make money on a job, no matter at what price it is taken. The situation is getting worse, and with the large amount of interior wiring now being installed, it is certainly essential that either the Underwriters or the Cities, or both, take immediate steps to prevent the continuance of this cheap class of work. The position of the electric light companies is materially affected, for though fires of electrical origin are of more or less interest to them, still the feature which concerns them most is the possible loss of life which may arise from defective wiring. We all know the difficulty of keeping the lines free from grounds. Theoretically it may not be impossible, though practically speaking it is so. Sometimes we can locate and remove a ground very quickly, but in other cases days may elapse before the trouble is remedied, and it is the luck of the under dog that somebody is going to get hurt during this period. The little contractor, who puts up the defective wiring in the house, does not come in for the same share of blame as the large corporation engaged in supplying electrical energy, and the well known habits of juries to render verdicts against large corporations makes the situation unpleasant. It is our opinion that the electric companies can be instrumental in obtaining a proper system of licensing and inspection. If they refuse point blank, and absolutely, to connect their lines to wiring systems which have not been installed by a licensed workman, and which have not been inspected, there will soon come a time when such licensing and inspecting will be universal. Whether it would pay the lighting company to have their own inspector is, of course, a question which must be worked out for each individual case, but in any event it is certainly within the jurisdiction of such companies to insist that all wiring shall be properly installed and shall be kept in first class shape.

The mercury vapor arc is being largely introduced for factory lighting, and is found to be remarkably efficient and economical.

TORONTO BRANCH A.I.E.E.

The annual meeting of the Toronto Branch of the American Institute of Electrical Engineers, was held at the Engineers' Club, 96 King street west, Friday evening, May 11th.

The report of the Secretary, Mr. R. T. MacKeen, stated that ten regular meetings had been held during the season, at which six Institute papers were abstracted and discussed and three original papers presented, the latter being as follows: "Multiple Operation of Transformers", by R. T. MacKeen; "Booster Control of Storage Batteries", by E. B. Walker; "Suburban Railways", by C. H. Wright. The membership increased during the year 20 per cent., this including Associate and Student members. On December 12 Mr. H. A. Moore tendered his resignation as Chairman owing to removal from the city, and Mr. R. T Mac-Keeh was elected to fill the vacancy.

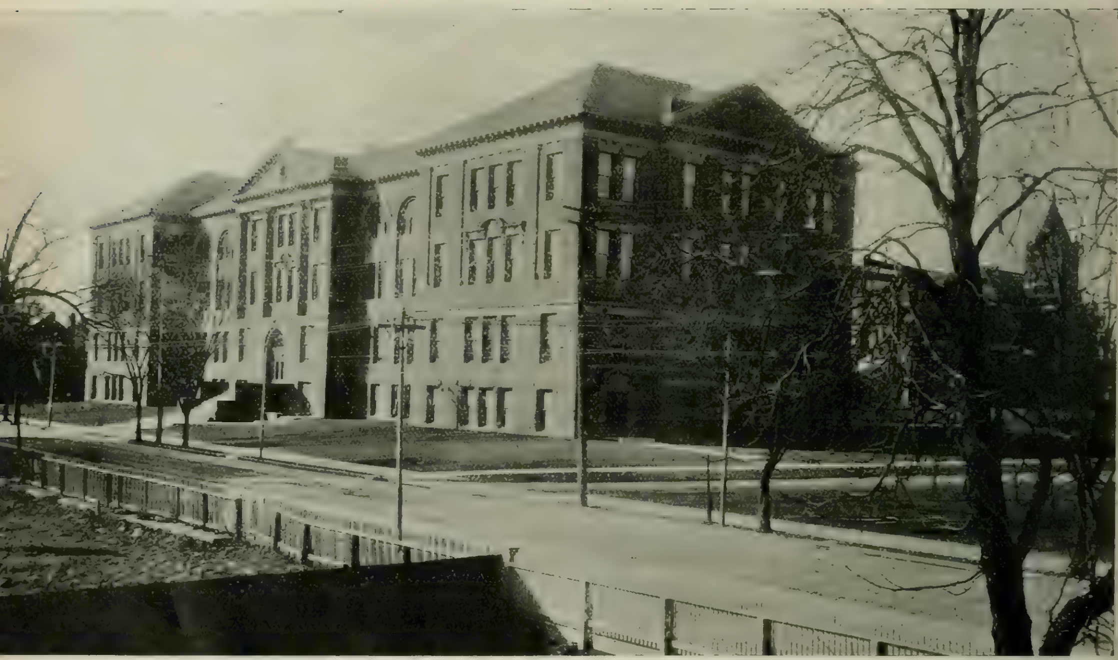
CHAIRMAN'S ADDRESS.

The Chairman in his address referred to several matters which vitally affect the interests of the Branch. He was particularly pleased with the growth of Student membership, which was indicative of an increased interest of the academical fraternity in the doings and sayings of their brethern engaged in the practical end of the work. He congratulated the Institute on having such active members as Prof. Rosebrugh and Mr. H. W. Price, who were largely responsible for the active interest taken by the students.

Referring to the welfare of the Branch the Chairman said: "This is an excellent opportunity of bringing before the membership a matter which is of vital importance to the branch work. Unfortunately, our activity is somewhat limited by the number of members we possess. Toronto is growing electrically each day and it is only a matter of time before our ranks will be swelled by men identified with electrical interests. It is important, therefore, that the Branch, in this its child stage, be fostered and strengthened. To do this we must have the individual interest and activity of each member. It is a fact that an organization of this character must look for success from this source, for there is no other. There are two classes of members:

First : The active class, which consists of men who are so sincere in their efforts to support an institution organized for the instruction and development of its members, that they come night after night, and in this way, and in taking part in discussion, assure the success of the meetings.

Second : The inactive class, who merely take a dilatory interest in our success, and rarely, if ever, attend meetings.



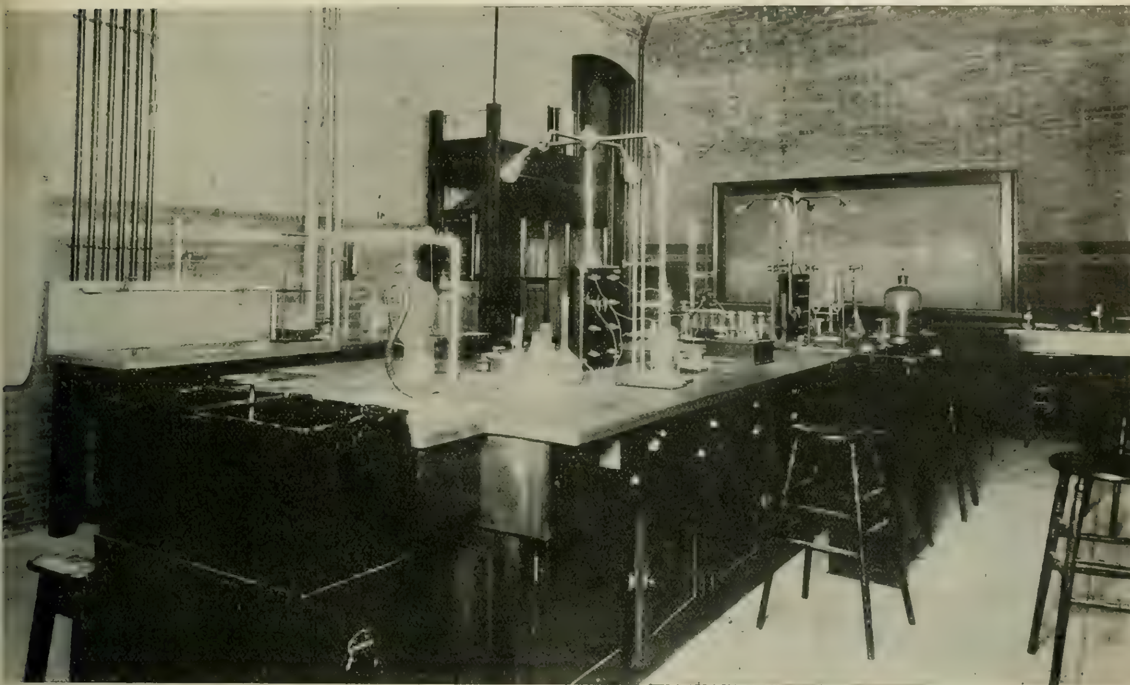
CHEMISTRY AND MINING BUILDING, SCHOOL OF PRACTICAL SCIENCE, TORONTO—VIEW FROM SOUTHEAST.

With the advent of the Student members our active class has increased largely during the past season, and the prospects for an increasing active element both Associate and Student, the coming season are most bright.

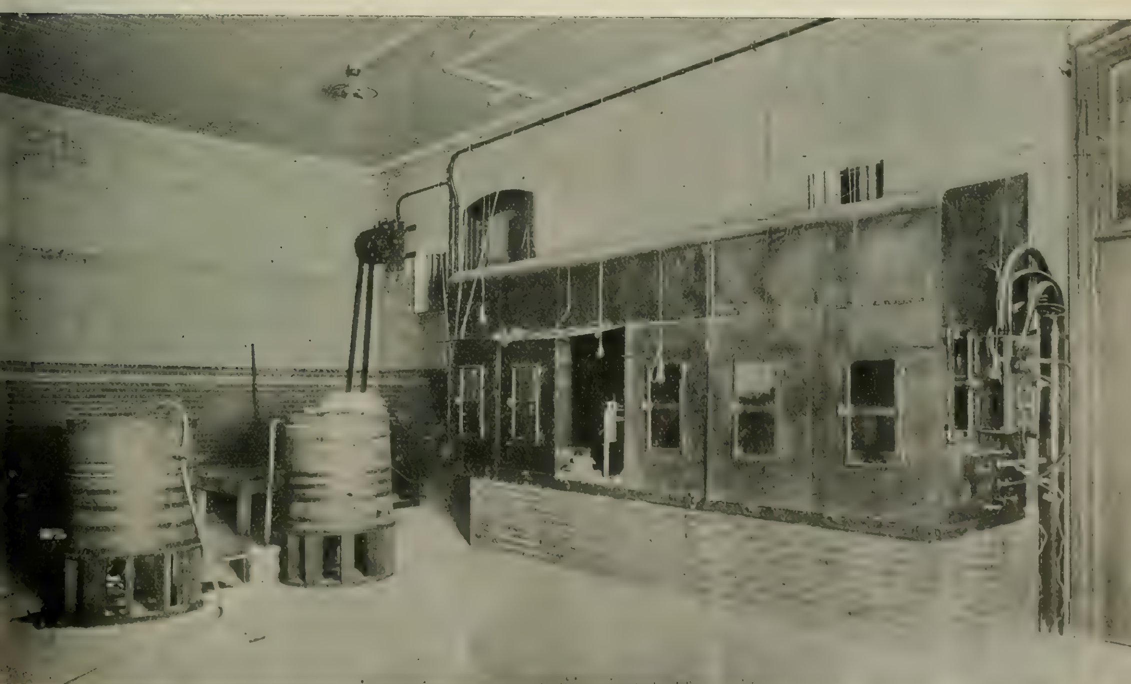
I wish to impress upon our members that the meetings are for their individual benefit, that is, the object of our meeting together is to give us all an opportunity to express our views upon subjects under discussion as well as to obtain knowledge from other members, and if this thought were more clearly recognized I think that more active and enthusiastic gatherings would result."

In conclusion Mr. MacKeen referred to the interest which the parent institute takes in the local branches and expressed his appreciation of the good will and fellowship of the various Executive officials of the Branch, who had helped him greatly in his work.

The following Executive committee was unanimously elected : Chairman, R. G. Black ; vice-chairman, K. L. Aitken ; executive, W. A. Bucke, H. W. Price and W. G. Chace ; secretary, R. T. MacKeen.



Chemistry and Mining Building, School of Practical Science, Toronto—Electro-Chemical Laboratory



Chemistry and Mining Building, School of Practical Science Toronto—Electro-Chemical Commercial Cell Room.

WESTERN CANADA

THE HYDRO-ELECTRIC DEVELOPMENT OF THE VANCOUVER POWER COMPANY.

One year ago we published some particulars of the hydro-electric power plant of the Vancouver Power Company then nearing completion for the purpose of supplying electric energy to Vancouver, New Westminster and other places. Since that time the original work has been completed, including the various sub-stations, and a complete description of the plant, from

Vancouver Power Company—Dam and Head Gates.

the pen of Mr. Wynn Meredith, the consulting engineer, appears in the Journal of Electricity, Power and Gas. It is perhaps advisable to again state, briefly, the general plan of development.

The main source of supply is Coquitlam Lake, which has an area of 2,300 acres and a watershed of 100 square miles. There is a dam at the outlet of Coquitlam Lake for the diversion and creation of storage, a tunnel connecting Coquitlam with Trout Lake and serving as a water conduit, a dam across the outlet of Trout Lake and pipe lines from this dam to the power house, situated on a navigable arm of the sea, jus above tide water. Trout Lake, used as a balancing reservoir at the head of the pipe lines, is separated from Coquitlam Lake by a mountain range rising 4,000 feet above its waters, the horizontal distance between the two nearest points being about two and one-half miles.

The normal sectional area of the tunnel is seventy-three square feet, the section being nine by nine feet, with rounded corners, and its total length is 12,775 feet.

For control of the flow of water through the tunnel two gates are provided in the main tunnel at a distance of sixty feet from the Coquitlam portal. The upper, or working tunnel, has been converted into a gallery from which the gates are operated by means of screw stems, ball bearing nuts and hand wheels, resting on a framework fastened rigidly to the rock by anchor bolts, while all the spaces between frame and rock are filled with concrete for water tightness. The gates are each four and one-half feet by nine feet, built up of structural steel and carrying on each side brass rollers, running on "I" beams, which form the framework. The gate carry flanges on each side, which seat only when the gates are closed.

The dam at the outlet of Coquitlam Lake is a rock-filled, timber crib structure, the cribwork being made of twelve inch by twelve inch sawn timbers, placed six to seven feet apart, center to center, and drift bolted together with three-quarter inch bolts. The quantity of timber used in its construction was 600,000 feet, board measure, and the cost, including the intake crib and head gates, $25,000.

The dam at the outlet of Trout Creek is of concrete consisting of one part Portland cement, two and one-half parts sand, and five and one-half parts crushed granite. The top of the dam was built up to the level of Trout Lake. It has a length of 361 feet and a maximum height of fifty-four feet. It has a width of thirty-five feet at its base, and a top width of seven feet, and contains 10,000 cubic yards of concrete.

There are ten fifty-four inch steel pipes and two twenty-four inch pipes penetrating the dam at a point twenty-two feet below its top. These pipes are all fitted with special roller gate valves at the face of the dam, with separate screens for each pipe.

The intake gate valves are placed in guides bolted to the face of the dam and are fitted with brass rollers, on which the thrust due to the water pressure comes. A circular ridge on the back of the gate is machined to make the seat and a corresponding seat is made on the gate frame, to which the pipes are riveted. These seats are not quite parallel to the plane of the rollers, so that when the gate is lowered to a certain point it takes its seat and the pressure on the rollers is reliev-

Vancouver Power Company—Wooden Stave Pipe Lines Below Dam.

ed, but immediately the gate is raised a fraction of an inch the pressure comes on the rollers again. The gear for operating the gate is a simple screw stem and hand wheel, with roller bearing which takes the pull. The gates are quite tight and can be operated with ease by one man at all stages of the water.

The pipe lines extend from the dam to the power house at sea level, for a total length of 1800 feet, and are built to curves and tangents both vertically and horizontally, no angles being allowed.

The upper portion of each pipe line is of wooden

stave construction, fifty-four inches in diameter, and extends from the dam for a distance of 800 feet to a point where it is under pressure due to seventy-five feet head. From this point to the power station the pipe lines are of riveted steel, varying in thickness from nine thirty-seconds inch to seventeen thirty-seconds inch and ranging in diameter from forty-eight inches to forty-two inches at the lower end.

At the present time three main pipe lines and one exciter pipe line are installed, the total length of each of the steel lines being 1000 feet. Each line is fitted with air valves at three different points, a relief valve at the lower end and a stand pipe just below the dam.

Vancouver Power Company—General View of Barnet Crossing.

The exciter pipe line is constructed of steel throughout its entire length and is twenty-four inches at the upper end and eighteen inches at the lower end. The thickness of plate varies from one-eighth to one-quarter inch.

The wooden stave pipes cost approximately $4.00 per lineal foot, the lumber being delivered at a cost of $37.50 per thousand feet board measure.

The cost of the steel lines was approximately $14.50 per lineal foot for the large pipes exclusive of excavation for the trench, which is 1800 feet in length and about thirty-eight feet in width. This work includes about 400 feet of trestle and 250 feet of tunnel, also about 3500 cubic yards of rock work in cutting down a bluff about seventy feet in height.

The power house was designed for an ultimate capacity of 30,000 to 40,000 h.p. It was decided to install the initial equipment of 9,000 horse power in three units, each unit consisting of one revolving field engine type, 200 r.p.m., three-phase, 2,300-volt Westinghouse generator and two Pelton water wheels, one on either end of the shaft, taking water from a single pipe through a Y connection and two deflecting needle nozzles, one to each wheel ; the shaft bearings and bed-plate being furnished by the water wheel makers. The needles are adjustable by hand to suit the maximum fluctuation of load and the nozzles deflected by type Q Lombard governors.

The revolving fields were especially designed and constructed to withstand a runaway speed, which might accidentally reach 175 per cent. or more. The hollow forged steel shaft carries the rotor centrally between the bearings, making a perfectly symmetrical arrangement and loading the two bearings equally.

Spatter water from the wheels is caught in a housing pocket and passed through the hollow shaft and also through the oil cellar of the bearings. The rotating element, including shaft, wheels and field, weighs 80,000 pounds. The water circulation system has proved of great value in maintaining cool bearings.

Exciting current is provided by means of either one of two direct connected water wheel driven generators, coupled to an induction motor, taking current from the main bus bars. The motor not only insures exciting current in the event of wheel trouble, but serves as a governor, absorbing as a generator the power of the wheel in excess of that required by the exciter.

The switchboard is located on a raised platform at one end of the power house. It is of the usual construction, equipped with Tirrill regulators, a full set of indicating and recording instruments and automatic oil switches. Two sets of bus bars are provided, one for the constant lighting load and one for the variable railway and power service. Two single throw switches are used in place of the usual double throw switch, one connected to each set of bus bars. This permits of transferring a generator from one bus to the other or feeding them in parallel without opening the circuit, thus providing great flexibility and insuring smooth service.

In a separate concrete building are installed the step up transformers, high potential switches and lightning arresters. There are three sets of three 555-kilowatt air blast, delta connected transformers, raising the voltage to 23,000 for transmission. The low potential side of these transformers is controlled by switches located on the main switchboard in the power house. The high potential side may be connected to either or both of two sets of bus bars and the four transmission circuits may in the same way be connected to either or both sets of buses.

The main switches required for this multiplicity of connections are of special design. They are of the

Vancouver Power Company—Substation from Gallery.

bayonet air brake type, and contain no oil. When a switch is closed the bayonet compresses a spring behind a piston which furnishes a slight blast of air at the precise moment the bayonet is withdrawn, thus blowing out the arc before any considerable metallic vapor is fprmed. The arc appears to be about one and one-fourth inches in length when breaking a 2,000-kilowatt 23,000-volt circuit. Westinghouse low equivalent lightning arresters are connected to each line, which is also provided with an ampere meter and a potential tell-tale.

Immediately outside of the transformer building

there is inserted in each line a set of ram's horns emergency switches, which are operated from either in or outside points.

The double forty-five foot pole line carries four three-phase No. 2 B. & S. gauge, medium drawn, copper circuits, two on each line. The wires are supported on nine-inch umbrella type Locke glass insulators, mounted on a special metal pin. At corners and points of extra strain the insulators are provided with a cast-iron cap cemented on. The right of way was cleared through a dense forest of large timber and cost $860 per mile. At Barnet the lines cross a navigable arm of the harbor. The distance between supports is

Vancouver Power Company—Back of Railway Switchboard.

2,750 feet and the conductors are 150 feet above high side at the lowest point.

Twelve seven-strand nine-sixteenth-inch galvanized plow steel cables are used as conductors. High ground on the north shore and twin towers on the south shore form the supports of the doubly insulated saddles holding the cables. Each cable is anchored to eye bolts at either end. These are sulphured in solid rock on the north end and secured to a concrete monolith at the south end. Anchorage insulation for each cable is secured by means of a series of thirty-two of the nine-inch glass line insulators, which are provided with cemented iron caps and supported by metal pins held in a double angle iron frame. The insulators are mounted in pairs, the cable passing between them. The strain is transmitted to the insulators by means of a clamp on the cable behind an equalizing bar, which transmits the strain to an insulator on either side, equally distant from the cable, by means of two U bolts having a curve of slightly greater radius than the neck of the iron insulator cap. This design permits the use of ordinary line insulators and it is worthy of note that any insulator can be replaced quickly and without difficulty. From Barnet the lines run almost due west nine miles to Vancouver. Three miles from Barnet one line runs south to the Burnaby sub-station, located on the electric railway connecting the city of New Westminster with Vancouver, and thence along the railway right of way to Vancouver, forming a loop. In this way the Vancouver and Burnaby sub-stations are served by two independent pole lines and four circuits.

A four-mile branch line from Burnaby to a sub-station in New Westminster supplies the municipally owned distributing lines with current for both incandescent and street arcs. From Vancouver a branch line extends seventeen miles to the delta of the Fraser River, where another sub-station is located that supplies current for the Lulu Island electric road and lighting and power service for Steveston, where the large salmon canneries are located. All sub-stations are of steel and masonry construction, designed for small fire hazard and low depreciation.

Transmission lines are all equipped with ram's horn disconnecting switches, located just outside of the buildings and arranged for operation from the inside. Flexibility of connections is obtained by means of a set of single pole automatic air blast switches in each station, which permits of any combination of circuits being made. From these switches two sets of high potential bus bars provided with low equivalent lightning arresters, are carried to the step down transformers, which are all of the air blast type.

The Vancouver sub-station is located on Westminster Avenue, and is a fine, substantial building 60x120, with large plate glass windows facing the avenue. In addition to the basement and main floor, there is a steel and concrete floored gallery, eighteen feet wide on the front and both sides. The air blast switches occupy the front portion of the gallery and the lightning arresters and transformer switches are located on one side, the railway switchboard being on the other. Spiral stairs give ready access to the gallery on either side. The open space in the middle is reserved for rotary converters, and is provided with a hand operated bridge crane traveling the length of the building.

Railway current is provided by means of two 500-kilowatt and one 1000-kilowatt rotary converters, with their complement of transformers, regulators and switchboard. Each rotary is provided with a direct connected induction starting motor and a direct current rheostatic starting equipment. The switchboard

Vancouver Power Company—Back View of Lighting Switchboard, Vancouver Substation.

contains both alternating current and direct current rotary panels, a totalizing panel and feeder panels.

The lighting and power service in Vancouver is supplied by means of eight 500-kilowatt step-down transformers, "Scott connected" for two phase, 2,300 volts. Current from these transformers is taken through a sixteen panel switchboard, provided with a full complement of instruments and switches. The single phase feeder circuits are each provided with a double throw oil switch for connection to either phase for balancing purposes, a time limit controlled oil cir-

cuit breaker and independent regulators. Recording voltmeters are used on each feeder, taking current from a pair of pressure wires connected at the center of distribution.

The tunnel was completed and water delivered through it June 10, 1905, and the plant has since been in successful operation. A fourth generating unit is now being installed.

Mr. Wynn Meredith was the consulting engineer for the complete development; Mr. H. M. Burnwell, engineer in charge of dams and pipe lines; Mr. E. B. Hermon, engineer in charge of tunnel, and Mr. M.C. McKay, engineer in charge of power house.

WINNIPEG ELECTRIC POWER PROJECT.

The report of the engineers appointed to advise on a municipal power development for the city of Winnipeg was submitted last month. The engineers were Col. H. N. Ruttan, City Engineer, Mr. C. B. Smith, C.E., and Mr. Wm. Kennedy, jr. The report states that the low water flow of the Winnipeg river may, by gauging taken, and comparing with the drainage area tributary in the province of Ontario and state of Minnesota, be taken at 19,000 cubic feet of water per second ; but certainly at not less than 17,000 cubic feet per second, and the latter quantity of water will produce on switchboard 1,420 effective electrical horse power for each one foot fall.

Two sites for water power development were surveyed, one at Seven Portages Rapids and one at Pointe du Bois (or 30 foot) falls, and the latter site is recommended as the more suitable. This location, 75 miles from Winnipeg, has a natural fall of 32 feet, and it is proposed by damming to raise the water some 13 feet higher, which, if necessary, can be further increased in dry weather to 14 or 15 feet ; but taking even a 45 foot head or total fall and using 17,000 c.f.s. as low water flow, a total development of 63,900 h.p. can be counted upon for 24 hours per day. Owing to there being seven square miles of reservoir area above this point a very much greater amount of power could be generated for the heavy load period of each day, up to a total of say 100,000 h.p. for several hours, allowing the reservoir to recover during each night, when the power demands are below normal.

It is proposed to build a canal 1,500 feet long, partially by excavation through solid rock and partially by concrete side walls, creating overflow dams, having 1,800 lineal feet of crest, thus avoiding any danger from high water and avoiding operating expenses attending on the use of stoplogs for controlling head water level.

The immediate development proposed is for delivery in Winnipeg of 17,000 h.p. of electrical energy stepped down ready for distribution on the low-tension busbars, together with such transmission lines and hydraulic and electric generating station expenditures as are necessary for safety of operation and for expansion of plant from time to time as the demand for power increases. Additional estimates are given showing the amount necessary to be expended to deliver 34,000 to 50,000 h.p. in Winnipeg under similar conditions as regards spare capacity to insure continuity of service as in the case of the present proposed development.

POINTE DU BOIS DEVELOPMENT—CAPITAL EXPENDITURE.

Items.	17,000 h.p.	34,000 h.p.	50,000 h.p.
Dams, including overflow and cut oft	$ 205,000	$ 205,000	$ 205,000
Canal headworks	25,000	25,000	25,000
Canal	157,000	157,500	157,500
Excavations, powerhouse and dams	90,000	90,000	90,000
Wheel-pits	100,000	100,000	100,000
Power house building	175,000	250,000	350,000
Machinery, hydraulic and electric	500,000	900,000	1,300,000
Transformer station	250,000	500,000	750,000
Transmission lines, 75 miles	630,000	970,000	1,160,000
Sub-station	215,000	430,000	645,000
Tramway, 20 miles	200,000	200,000	200,000
Totals	$2,547,500	$3,877,500	$5,082,500
Engineering, 5 per cent.	127,375	193,875	254,125
Contingencies, 10 per cent.	254,750	387,750	508,250
	$2,929,625	$4,459,125	$5,844,875
Interest during construction, 5 per cent.	183,101	278,695	365,305
Total investment	$3,112,726	$4,737,830	$6,210,180
Capital cost per h.p.	$183	$139	$124

POINT DU BOIS DEVELOPMENT—CAPITAL AND OPERATING CHARGES.

	17,000 h.p.	34,000 h.p.	50,000 h.p.
Interest, 4½% on capital	$140,072	$213,202	$279,458
Operating charges and repairs to transmission line	24,999	40,146	47,045
Operation and repairs, sub-station	24,035	45,770	67,405
Operation and repairs, transformer station	26,500	51,500	76,500
Operation and repairs, power-house	70,446	95,908	122,584
General administration	20,000	25,000	30,000
	$306,052	$471,526	$622,992
Cost of 24-horse power per h.p. per year at sub-station, low tension busbars, ready for distribution	$18.00	$13.87	$12.46

WESTERN SPARKS.

New C.G.E. machinery is now being installed in the municipal power house at Victoria, B.C., the same being furnished by Messrs. Hinton & Company. New enclosed arc lamps will also supplant the open arcs which have beeu in service for many years.

At a recent meeting of the Fire, Water & Light Committee of Winnipeg, a letter was read from Mr. F. A. Cambridge, City Electrician, stating that steps should be taken to provide protection from the high tension electric wires coming into the city from the Lac du Bonnet plant. The question of electrolysis was also taken up, it being pointed out that the current of the Winnipeg Electric Street Railway Company had already done considerable damage to the water mains.

A good deal of electric wiring has been done in the town of Fort Frances, Ont., during the past winter, in anticipation of the completion of the electrical power plant there by the Backus-Brooks Company, of Minneapolis. A new town hall and two large hotels have been put up there during the past winter and are being wired throughout by A. C. Waltz & Company, of Po Arthur. Besides these Messrs. Waltz & Company have wired a number of new houses and installed fixtures in same, to be all ready when the current is turned on.

A new firm, known as Anderson & Anderson, has recently opened up business in Port Arthur to engage in all kinds of electrical construction and installation work. Their offices and show rooms are in the Chausse Block, where they carry about $6,000 worth of stock, including full lines of electrical fixtures, motors, arc lamps, bells and annunciator systems, etc., etc. Mr. C. E. Anderson, the senior partner, has had a world-wide experience in electrical work, having been engaged in that business in Sweden, Germany and Australia before coming to Canada.

The town of Port Arthur, Ont., is erecting a $25,000 building for municipal purposes. The building is to be three stories high, solid brick on stone foundation, occupying a site 35 x 75 ft. The cellar will be used for a public library, the main floor for the secretary-treasurer's and city clerk's departments, the first floor for committee rooms, and the top for the municipal telephone exchange. A new switchboard, capacity 1,000 lines, will be installed, the central energy system being used. The present switchboard is greatly overcrowded, there being over 650 telephones used in the town, this being an average of one phone to about every ten of the population.

Compounding of Rotary Converters*

It is a well-known fact that there is a certain adjustment of rotary converter field strength that gives a minimum alternating current input for a given direct current output, and that varying the field strength either way will increase this alternating current input, while the direct current output remains the same. In every case the alternating current input may be considered as being made up of two components: one, the energy component in phase with the impressed electromotive force; the other a wattless component, leading with respect to the line voltage when the field strength is too great and lagging when the field strength is too small.

A constant alternating current voltage across the collector rings has been assumed, and it is evident that the constancy of this applied voltage means the generation of partically a constant voltage by the rotation of the rotary converter armature. To generate this constant voltage armature (which runs at a definite speed) there must be a constant magnetic induction through the armature, and therefore a constant number of ampere-turns to produce that induction.

In a rotary converter, or other synchronous machine, there are two sources of excitation, current in the field winding and current in the armature winding. To produce a constant voltage the sum of these two excitations must be a constant. If the ampere-turns in the field winding are less than necessary, a current circu-

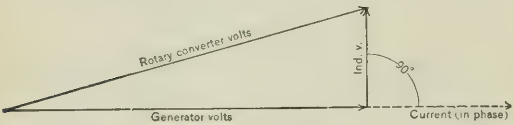


FIG. 1. E. M. F. DIAGRAM, CURRENT IN PHASE.

lates in the armature in such a manner as to assist the field in magnetizing the armature. Such a magnetizing current, though leading with respect to the electromotive force of the converter regarded as a generator of electromotive force, is lagging with respect to the generator or supply system. On the other hand, if the ampere-turns of the field winding are more than sufficient to produce constant voltage we have assumed, a current circulates in the armature in such a manner as to oppose the field winding and so reduce the magnetic induction to the required amount. This magnetizing current is leading with respect to the generator or upply system.

The actual current circulating in the armature may be regarded as being composed of the magnetizing current and the useful current, and the ratio of this useful component to the resultant of the useful and magnetizing components is known as the power factor of the circuit. It is measured by the ratio of the true input (recorded by a wattmeter) to the apparent input (recorded by an ammeter and voltmeter.)

From the above analysis it is evident that the power factor of the alternating current taken by a rotary converter is intimately dependent on the amount of its armature magnetizing or demagnetizing current, and therefore dependent on the field current of the converter. The limits of variation of power factor are from a very low power factor lagging to a very low power factor leading. The first occurs with a small or no load when the field excitation is too low, and the second with a small load or no load when the field excitation is too high.

From this it will be seen that variations in shunt field strength give lagging or leading current in the alternating current line. It does not, however, affect the armature magnetization, and so a change in shunt field strength alone cannot affect the direct current voltage. This bears a fixed relation to the alternating current voltage so that the only way to raise the direct current

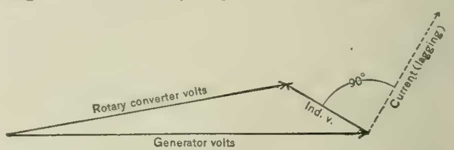


FIG. 2. E. M. F. DIAGRAM, CURRENT LAGGING.

voltage to any extent is by raising the alternating current voltage at the collector ring.

Now the voltage at the collector rings of a converter is the resultant of two components; first, the voltage of the generator; and, second, the voltage needed to force the current taken by the converter through the inductance between itself and the generator. The resistance between the generator and the converter is also a modifying element, but we will temporarily assume this resistance to be negligible, and without attempting at this point to give reasons, state the facts concerning the resultant of the two components.

(1) As long as the current supplied to the converter is neither lagging nor leading, the inductance volts combine with the generator volts in such a manner that their resultant, the converter voltage, is practically the same as the generator voltage; that is, a non-inductive load causes practically no drop over that due to the resistance of the line.

(2) If the converter current is lagging, the two elements combine in such a way that their resultant is smaller than the general volts; that is, the electromotive force of self-induction causes an increased drop over that due to line resistance.

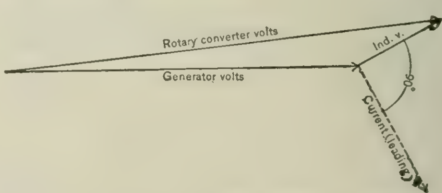


FIG. 3. E. M. F. DIAGRAM, CURRENT LEADING.

(3) If the current is leading, the resultant is greater than the generator volts; that is, the e. m. f. of self-induction in this case adds to the generator volts.

It is evident, therefore, that if we can cause the current taken from the rotary converter to change from lagging at no load to leading at full load, the voltage applied to the converter will change from an amount less than the generator voltage at no load to an amount greater than the generator voltage at full load,

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and this is exactly the function of the series field. It makes the field ampere turns increase with load, and therefore as set forth above causes the lagging component of the current supplied to the rotary converter to decrease, or the leading component to increase, or both.

Now to explain somewhat further the reasons why the resultant of the two components which make up the converter voltage increase as the current changes from lagging to leading. The volts across an inductance (the e.m.f. of self-induction) lag 90° behind the current causing them (the resistance being negligible). This lag remains fixed under all conditions. If therefore the current is neither lagging nor leading, with reference to the generator volts, the inductance volts caused by that current lag 90° behind the generator volts. This condition is shown in Fig. 1, where it is evident that the rotary converter volts are practically of the same value as the generator volts. Now, if the rotary converter current lags, the inductance volts are thrown around into such a position that the resultant of them and the generator volts is smaller than the generator volts. This condition is shown in Fig. 2. If, on the other hand, the rotary converter current is leading, the resultant of the two elements is greater than the generator volts as shown in Fig. 3.

It will be noted that the amount of compounding depends upon two things :

(1) Upon the variation in power factor between no load and full load, or, referring to the diagrams, upon the change in angle between the generator volts and the inductance volts.

(2) Upon the drop across the inductance, or referring to the diagrams, upon the length of the line representing inductance volts, compared to the length of the line representing generator volts.

The first condition depends upon the relative amount of series winding on the rotary converter, and this is covered by the standard specification of the Westinghouse Company. The second, the inductance in circuit, depends, however, upon conditions outside of the rotary converter, over some of which the company has no control whatever. For this reason the Westinghouse Company declines to make guarantees on the compounding of rotary converters unless conditions governing inductance in the circuit are thoroughly known.

In a rotary converter plant there are usually three sources of inductive drop, the step-up transformers, the line, and the step-down transformers. In specific cases, however, any or all of these sources may be absent. For instance, where a rotary converter is operated directly from a generator in the same building, there will be practically no inductance between the rotary converter and the generator. In order to obtain compounding in this case, it is necessary to insert inductance (usually choke coils) between the rotary converter and the generator.

In any case where this becomes necessary it should be borne in mind that the voltage applied to the rotary converter is not that of the generator alone. The "drop" across the choke coils (inserted for the purpose of giving compounding) should be subtracted from the generator voltage to obtain the true rotary converter volts at no load. The amount to be thus subtracted will depend both upon the amount of inductance in the choke coils and also upon the percentage of full load current for which the rotary converter shunt field is adjusted at no load.

This reduction of voltage at no load applies to the rotary converter, whether in the same building with the generator, or at the end of a long line; in the latter case, however, the problem is somewhat complicated by the addition of a resistance drop as well as an inductance drop.

The two general statements that follow in regard to the compounding of rotary converters are approximately true.

(1) A rotary converter which will compound 10 per cent. when operated as a direct generator will require from 12 per cent. to 15 per cent. inductance in order to make it compound 10 per cent. when operated as a converter. This statement assumes that the ohmic drop in the transmission line is negligible. When an appreciable ohmic drop occurs, as for instance at the end of a long transmission line, the regulation will be reduced by practically the percentage of the ohmic drop that occurs.

(2) In a rotary converter that will compound 10 per cent. as a direct current current generator and is on a circuit with from 12 per cent to 15 per cent. inductance, the proper adjustment of the shunt field will be such that at no load the rotary converter takes 30 per cent. full load lagging current. With the shunt field adjustment unchanged, full load voltage applied, the power factor will be 90 per cent. leading.

The question may naturally be raised as to what is meant by 12 per cent. to 15 per cent. inductance and how it can be measured Twelve per cent. inductance in a rotary converter circuit means that it requires 12 per cent. of full voltage to force full load current through the self-induction of the rotary converter circuit. In other words, if the rotary converter be short circuited at its collector rings, it will require practically 12 per cent. of full voltage at the generator to force full load current of the converter through the circuit (assuming zero resistance). The self-induction of the generator armature is omitted in this latter statement, as in cases where the generator is large compared with the rotary converter (and this is usually the case) the self-induction of generator armatuse is an inconsiderable part of the total self-induction.

If at any time it becomes necessary to measure the inductance volts it may be done by short circuiting at the collector rings and measuring the voltage necessary to force full load rotary converter current through the circuit. This will include resistance volts as well as inductance volts. To eliminate the resistance element, calculate the percentage of full load volts that it requires to drive full load rotary converter current through the circuit to the short circuited point. The percentage of inductance volts will then be the third leg of a right angled triangle of which the percentage of full load volts measured above is the hypothenuse and the percentage resistance volts is the second leg.

For example, in a 2,000 volt system suppose it takes 400 volts at the generator to force the full load current of a rotary converter through the circuit when the converter is short circuited at the collector rings. This means 20 per cent. of full voltage. Suppose, further, that a calculation shows that it will require 300 volts or 15 per cent. of the generator voltage to force the same current through the resistance of the circuit. By making 20 the hypothenuse and 15 one leg of a right angled triangle we find that about 13.2 is the third leg. That means that there is about 13.2 per cent. inductance in that circuit..

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstaces warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. No. 1.—Four large water wheels, two right and two left hand, vertically set, are connected to the lay shaft by crown wheels and pinions. The bearings supporting the lay shaft are bolted to the cross beams and the concrete on the top of the parting walls of the penstocks. If the shaft, which is coupled in three sections, be slightly sprung near the pinion of the wheel next the generator, what would be the effect on the following parts? (a) The running of the generator. (b) The bearings along the lay shaft and the babbitt. (c) The wooden cogs in the crown wheels, as to their wear and running respectively. (d) What would be the general characteristic as to the running of the whole? (e) If the shaft were removed, and it was impossible to straighten it accurately, would taking a cut off the shaft at the bearing next the pinion, and re-babbitting the journal,remedy or improve the trouble? (f) How could it be proven that the shaft is sprung?

Ans.—It is extremely difficult to give an intelligent answer to the above questions without a personal examination of the apparatus. We would suggest to our subscriber that he get a capable engineer to examine the machinery, and report upon it, as this really will be the only way to get accurate information concerning the proper remedy for the trouble. However, we will answer the questions to the best of our ability, and hope that the information may be of some use. (a) If the spring is serious, the effect will be noticed in the generator through the fact that there is considerable vibration, and an unnatural or previously unnoticed heating of tbe bearings. (b) The same effect will be noticed on the horizontal shaft. (c) The wear on the cog wheels will be unnaturally great, and running will not be smooth. (d) Vibration, heating, and wear would be the principal characteristics. (e) Your suggestion for remedying the difficulty has been tried, and succeesfully used with small shafts. We understand, however, that your shaft is about eight inches in diameter, and it is doubtful if this method could be used as anything but a temporary or emergency repair. You might be able to straighten the bent section, though this will leave the shaft weak, and if it were subjected to a strain similar to that which caused the original spring, the subsequent spring would probably be much more serious. If your equipment is running sufficiently badly to demand an immediate change, we are inclined to think that a new section of shaft will probably be the cheapest and most satisfactory solution. (f) The really reliable way would be to place the shaft in a lathe.

Ques. No. 2.—Will you explain through your question column why two-phase generators are used at Shawinigan Falls, while the transmission line is three-phase? I ask this question because it would appear to me to be for the purpose of obtaining a balance on the generators.

Ans.—For the long distance transmission of power, Charles F. Scott advocated some years ago a system made up as follows:—The generators were two-phase machines, the step-up transformers were connected on the Scott system of two-to-three-phase transformation, and the enengy was carried from the power house to the sub-station in the form of three phase current. Here the step down transformers were Scott connected, and the distribution was made at comparatively low pressure over two-phase lines. Probably the reason for this system was that the three-phase generator, and three-phase distribution, presented complications in the early days which made it desirable to substitute two-phase. The economy of three-phase transmission, however, was well recognized, and hence the Scott system enabled the power company to adopt a scheme which was satisfactory in each department, namely, two-phase generators, three-phase transmission, and two-phase distribution. In modern work, it seems the pretty generally adopted principle to use three-phase throughout the entire system.

QUES. No. 3.—How do you figure the quantity of water required for condensing with a compound steam engine?

ANS.—It is a simple matter to ascertain the amount of water which will be required by either a jet or surface condenser if the simple rule be borne in mind that there is a certain amount of heat in the steam, and that this heat has to be transferred to the condensing water. A 26 inch vacuum corresponds approximately to an absolute pressure of two pounds per square inch, at which pressure the steam will have a temperature of approximately 126 degrees Fahrenheit. In one pound of steam at this pressure the latent heat is equal to 1,026 British thermal units, and therefore a quantity of water will be required which is capable of absorbing this heat, reaching a final temperature not exceeding 126 degrees Fahrenheit. Assuming that the condensing water is at a temperature of sixty degrees Fahrenheit, we are then able to figure on raising its temperature sixty-six degrees, which will require approximately sixty-six British thermal units per pound. If we divide 1,026 units (the amount contained in one pound of steam in the form of latent heat) by sixty-six units (the amount absorbed by one pound of water) we find that fifteen and one-half pounds of water are required to condense one pound of steam. This, of course, is the theoretical amount for the above stated conditions. In actual practice a combination of lower vacuum, and higher initial temperature of condensing water, will require a greater weight of water per pound of steam condensed. In warmer climates it is the custom of manufacturers to require an available quantity of condensing water at least twenty-seven or thirty times the weight of steam which is expected to come from the engine. While in some rare cases this quantity of water will actually be required during the summer months, still the average consumption of cooling water will be found to be very much less.

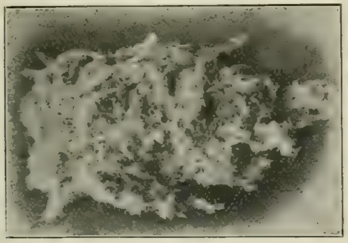
QUES. No. 4.—How do the efficiencies of triplex and centrifugal pumps compare, in small sizes, and what are the advantages of each type?

ANS.—It is practically impossible to give reliable information in answering the above question without knowing the makes of the pumps, their capacities, and the heads against which they operate. Assuming, for the sake of illustration, that both pumps will deliver one hundred gallons per minute against a one hundred foot head and a suction lift of ten feet, we would be inclined to say that the efficiency of the triplex pump would be in the neighborhood of sixty-five to seventy per cent., while that of the centrifugal pump would be between forty and fifty per cent. The term efficiency, as used here, is the ratio of the power delivered to the pulley of the pump to the theoretical amount of power taken from the quantity of water, and the height to which it is elevated. The centrifugal pump, while having a lower efficiency, has many points in its favor. There are no valves to get out of order, solid matter can pass through the pump, the discharge may be suddenly cut off without damage, and the first cost and maintenance is considerably lower.

MINING ASBESTOS, OR MINERAL WOOL*

By Aubrey Fullerton.

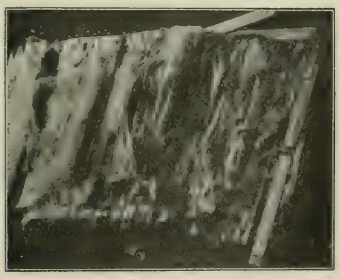
Known to some extent in ancient Greece and Egypt, the existence and uses of asbestos seem afterward to have been forgotten until quite recent years. The revival dates from about the beginning of the last century, when mines were opened in northern Italy.



Fiberized Asbestos Ready for the Market.

Since 1866 the Italian mines have been the chief source of supply in Europe, and until twenty-five years ago they were the only mines in the world. At the present time, however, asbestos is being mined in varying quantities in Russia, Australia, and Africa, and most largely of all in America. It occurs in some nine or ten of the States, of which Georgia produces the largest quantity and Vermont the highest grades. The veins thus far discovered in the latter State are closely similar in character to those north of the international boundary, where, in the Province of Quebec, is the world's chief storehouse of asbestos. Of the grades suitable for the highest class of manufacture—which, in other words, means the grades suitable for spinning and weaving—Quebec has practically a world monopoly.

What makes one variety of asbestos of greater commercial value than another, and one country's deposits better than those of some other country, is the fiber of the stone; and upon this essential difference is

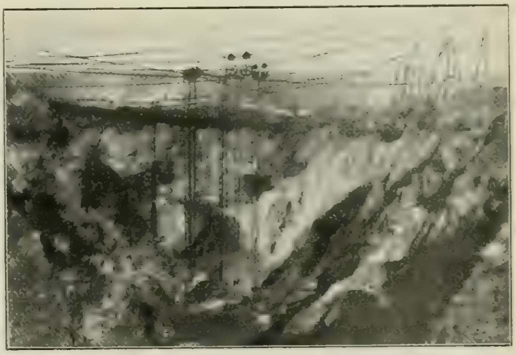


Asbestos in Raw State, as Taken from Mine.

based the division of the natural stone into two quite distinct classes. It is amphibole or actinolite when its crystals occur in long, slender prisms or in radiating masses, whose fibers are harsh and brittle, and whose composition is about 60 per cent. silica and 25 per cent. magnesia; it is chrysolite or serpentine asbestos when its fibers are long, slender, flexible, and easily separable into fine, silky threads that are highly elastic and capable of being spun. Quebec's supply, which is the source of the bulk of the asbestos used in the United States, is of this kind.

Chrysolite, the asbestos of the finer commerce, is in chemical terms a hydrous silicate of magnesia. The Canadian fiber, which is made especially soft and silky by its large percentage of water—over thirteen per cent.—is practically the same as the best Italian fiber; but Italy's supply of chrysolite is small, and so far as known this form of asbestos exists in paying quantities only in Canada.

Geologically it is a fibrous form of serpentine, occurring in strata of crystaline limestone. The serpentine—or verd antique marble, as it is popularly called—is of a greenish color; and the asbestos itself, which is found in small veins or layers, is light yellow or light green, and highly transparent. The veins run in an average thickness of from one-quarter to one-half inch, but sometimes of three, four and even six inches. Since the fiber runs crosswise, the thickness



Quarry of King Brothers' Asbestos Mine, Thetford, Que.

of the vein means also the length of the fiber; and the longer the fiber, the better and more workable is the asbestos.

How this remarkable substance ever came to exist, is a question whose answer dates back to Creation times. Briefly the theory is this: The original rock, thrown up by igneous action, developed cracks and seams as it cooled; and as these rocks changed under the action of water and vapors to serpentine, the seams gradually filled with serpentine deposits from the rock walls, in a fibrous structure. The asbestos fibers are, as nearly as possible, crystals of serpentine; hence their inconsumability.

The ore is mined mostly in open quarries. Overlying soil, to a thickness of sometimes twenty or thirty feet, but quite often forming only a thin layer on top, has first to be removed; and as soon as the asbestos veins are thus laid bare, the actual quarrying operations may begin. The rock is cut in a series of terraces, reaching a total depth of sometimes 150 or 200 feet. Underground work has not proved successful, the open quarry having been found both more economical and more effective, despite the disadvantages of exposure to the weather. Drilling and blasting are employed much the same as in ordinary stone quarrying.

When the rock is thus broken up it is rough sorted

* Abstracted from the Technical World Magazine

at the quarry. Two or more grades are selected according to the length of the fiber and are then sent on to the "cobbing sheds", where the further process of dressing goes on. This process is merely the separation of the asbestos fibers from the dead rock, and is done in some cases by hand but to an increasing extent by machine. Hand-cobbing is the very simple method of breaking the stone by small sledge hammers, throwing the fiber into one box and the waste into another. This separation is ordinarily not difficult, since the fiber lies in layers more or less loosely clinging to the rock, and can frequently be picked off with the fingers. The crude fiber, thus separated as cleanly as possible from the waste rock, and looking very much like mineralized wool, is packed in 100-pound bags, in which form it goes to the market and the manufacturer.

Hand dressing is not, however, an absolutely thorough method. The waste material from the cobbing tables, and the fine pickings from the quarries, have still some fiber in them; and the utilization of this frequently represents the largest profits of the mine. All these finer pickings are mechanically dressed. In case the asbestos contains a large percentage of water, the moisture is first dried out, by exposure to the air, by steam pipes, or by rotary driers; and the rock is then passed on to the crushers, where it is broken by successively finer-set rolls. Cylindrical fiberizers and the cyclone machine reduce it still further. The latter is the most effective apparatus yet devised for asbestos separation. It consists of two beaters, of the screw propeller type, driven within a cast iron chamber at a violent speed, reducing the particles of stone almost to a power. This is then passed over a shaking screen to remove the sand; and in some mills strong electric magnets are used to take up the particles of iron.

The natural qualities of the asbestos ore vary considerably in different localities, and methods of treatment vary accordingly. The general principles, however, are essentially the same. Of the total rock mined in the Canadian areas, from 30 to 60 per cent. is suitable for milling, the percentage of waste having been greatly reduced by the introduction of mechanical dressing; and of the rock sent to the mill from 6 to 10 per cent. is fiber. Each ton of asbestos mined and milled costs about $17.50; and the market price runs from $25 for the poorest grades, suitable for paper and mill-board, to $200 for the best commercial grades.

When the dressed asbestos finally reaches the market, the uses to which it is put are almost unlimited, and depend entirely upon the length and quality of the fiber. The very fine fibers—those produced by the mechanical fiberizers from the tailings and waste heaps—are manufactured into various pulp and powder forms. As a fine powder, they are made up into fireproof paints, which are widely used for rough woodwork and possess quite remarkable fire-resisting qualities. As sold to the consumer, these paints are ready for use with the addition of water. Very fine fiber, of the best quality and thoroughly cleaned, is also of great value as a filter medium, the more so because it is proof against the action of acids and alkalies.

Fine-ground asbestos has often been experimented with as a stock for paper. As far back as 1866, some ingenious Italians attempted to produce a paper which they hoped would be adopted by the Government for securities and bank notes, but their experiments were not successful. Later and more satisfactory experiments were made in Paris and elsewhere, and a fair grade of asbestos paper has been produced. Its chief drawback is that it will not take a good sizing, remaining much like blotting paper; and while it is itself quite fireproof, it does not retain the writing under a severe fire test.

Panoramic View of Asbestos Mines of the H. W. Johns-Manville Company at Danville, Quebec.

Asbestos millboard, resembling in character and method of manufacture the ordinary wood-pulp cardboard, is already a commercial success. The fiber mixed with water is thoroughly beaten in large tanks; then ingredients that will bind the fiber together are added, and the pulp in this condition is passed over a wire cylinder, through which the water is drained off. The residue of pulp thus gathering on the wire forms the board, which is then pressed, cut, and dried like ordinary paper board. This asbestos millboard is used for box material, such as for fireproof deed boxes, etc., and more particularly as a joint packing for steam pipes.

Another of the paper forms in which the poorer grades of asbestos fiber are very widely used, is that of roofing material. Some varieties of this are made with a canvass center and asbestos felt or paper on either side, giving a fabric that is not only fireproof but of great durability. A later invention comes from Austria, where the very fine fiber is ground with a mixture of serpentine, then with ashpalt and other ingredients. This process is now being introduced in the United States. Asbestos wall plaster is a similar production, also composed of fine fiber mixed with serpen-

ine. It is applicable wherever plastering of any kind is required ; and as it supplies its own fibers and rock dust, neither hair nor sand is necessary. It is being used in a large number of the new fire-proof buildings. Indeed, an asbestos building, from cellar to roof, may soon be possible, for recent experiements in fireproof bricks, composed of asbestos lime and sand, have been very successful, the bricks so resisting a 2,000-degree temperature as to be no more than slightly warmed. Floor tilings are a recent novelty now being made in Georgia.

But perhaps the form in which asbestos is best known to the American building and engineering trades is in the several varieties of insulating material. As a covering for steam pipes and boilers, it is in use in nearly every modern office building in the country. In this capacity it serves the threefold purpose of saving fuel, increasing power, and reducing temperature. Ordinary uncovered two-inch pipes, with steam at 75 pounds, will lose one horse-power for every 132 feet of their length ; and four-inch pipe, a like loss for every 75 feet. Ten square feet of bare pipe will waste in one year two tons of coal. Asbestos pipe-coverings pre-

Moulding Covering for Steam Pipe.

vent this loss ; and that is why the specifications of the best modern buildings call for every inch of their pipes to be covered. A fifteen-story building now going up in Toronto will have eight miles of asbestos pipe-covering ; the United States battleship Oregon has seven and a-half miles on its boilers and steam pipes ; and other buildings and ships of all kinds and types have corresponding quantities. In electrical installations, asbestos preparations are found similarly useful for insulating wires and for preventing overheating in electrical machinery.

This insulation of steam pipes is effected by applying a paste of asbestos fiber and magnesia to the surface of the pipe and binding it with canvas or oilcloth, or by fitting the pipes with sectional coverings, ready-made in various sizes, and bound with iron or brass bands. The latter covering is constructed of layers of plain and corrugated asbestos felt, whose numerous air-cells effectually prevent radiation.

With the better grades of asbestos fiber, still more remarkable results are obtainable. The fiber that we use in our gas grates, furnishing a very pleasant and powerful heat as the burning gas rises through it, is a fair specimen of the better qualities after being milled, but still unmanufactured. The highest excellence of the fiber consists in its fitness for spinning. For this, only the longest fibers are suitable, and they are best when softest and most elastic.

An important use of asbestos cloth is in the manufacture of theatre curtains. The value of such curtain has been repeatedly proven ; and after the Iroquois Theatre disaster in Chicago, the demand for them and similar fireproof material was for a time especially active. Asbestos cloth is also made up into firemen's uniforms, consisting of boots, pants, aprons, gloves, mask, and head-gear. One or two men in each company, thus clad, can effectively do work that would otherwise be impossible. Iron workers and glass moulders wear aprons of asbestos cloth as a protection from the severe heat in which they work.

In America the increasing use of asbestos packing and pipe-coverings, particularly for office buildings and factories, furnishes a demand for the shorter fiber ; in Europe, where building conditions are somewhat different, there is a much smaller market for these preparations, and a correspondingly greater demand for the spun and woven wares. In the manufacture of the latter, particularly in the English and French mills, the fiber from the mines of Italy and Russia is mixed with Canadian fiber, the combined product having for some purposes a superiority over either alone. Much the largest part of the Canadian output, however, is used in the United States and Canada. The mines in the Quebec district are operated by some ten companies, in which United States capital is largely interested. The ore is milled in Canada and shipped in fiberized form to the manufactories in New York, Pennsylvania, and elsewhere, where it is made up into the finished commercial wares. One of the earliest companies to operate in the Canadian areas, and the first to introduce mechanical dressing, was a company of Scotch capitalists; and a considerable portion of the output still goes to Scotland and England. German capital is also interested. The annual production of the Quebec mines alone is about 50,000 tons.

While Quebec has practically a world monopoly of of the best grades of asbestos, and in presumably inexhaustible supply, the neighboring Province of Ontario has considerable deposits of the kindred mineral, actinolite, or hornblende asbestos. Actinolite is very similar to the chrysolite asbestos in its chemical characteristics, and is equally effective in heat-resisting, but it is not so good a non-conductor and lacks in strength of fiber. It is used to some extent in roofing material and plaster. The essential difference between the two varieties is that, while chrysolite is a hydrous silicate of magnesia, the hornblende asbestos is an anhydrous silicate of lime and magnesia, and therefore without the softness and oily feel which characterize the better grade.

Mr. E. W. Skinner, acting for the town of Carman, Man., has placed a valuation on the plant of the Carman Electric Light & Power Company, and it has been decided by the council to submit a by-law for the purpose of raising $58,000 to cover the cost of an electric light plant, waterworks and sewerage systems, and fire protection.

Mr. C. H. Rust, City Engineer of Toronto, has reported against the purchase by the city of the Southern Light & Power Company's plant at Erindale. He found that the plant is capable of developing about 1200 horse power, but to acquire the presen property and to complete the plant will require possibly half a million dollars, and this amount the engineer considers to be too high a price to pay for that amount of power.

LIVE WIRES.*

By H. F. Strickland,
Chief Electrical Inspector Canadian Fire Underwriters' Association.

The talk of "live wires" has probably done as much to create uneasiness in the minds of the masses as actual damage that has been positively demonstrated to have resulted therefrom.

The name implies "alive wires," and to the susceptible nerve and the active imagination "alive wires" can be seen burning buildings and pursuing harmless and inoffensive citizens in demoniacal form.

It may strike my hearers as somewhat odd, but it is nevertheless none the less impressive, that, having for a period of nearly twenty years been actively engaged, directly and indirectly, in all the various phases of electrical work, I have yet to witness the actual starting of an electrical fire; while, during the same period, I have had in my own house three incipient fires, one from a hot stove-pipe, one from a gas jet, and one from the spontaneous combustion of some rags that had been used for oiling floors and were left in a wooden box in a cupboard.

This experience of one so closely in touch with electrical work as I have been should dispel to a certain degree the idea of danger from electric wires that exists in the minds of many.

The danger of electric wires has been to a large extent fostered by the use of this as a trade argument by contractors against bad work. While there is some ground for the argument, it has been given undue weight, since it has spread to the fire chiefs and thence to the press, so that, until some other favorable cause can be discovered, it will be the assigned cause of fires in all cases where the cause can not be absolutely proven to the contrary. Notwithstanding the fact that the danger is exaggerated, there are in all cities a number of people doing electrical work who are both incompetent and unscrupulous, and this is a fact which does exist, and if there was no system of inspection to keep continually on the heels of these people, there is no doubt that there would be a lot of serious damage to life and property.

A resumè of some of our great fires may interest many here assembled. Commencing now and looking backwards we come to our last serious fire, viz.: that at 27 Richmond street west, during the last month, where the Oxford Press and Book Rooms were totally destroyed, entailing a loss of some $30,000. The cause of this fire was assigned to electric wires by all the evening papers, but upon thorough investigation by myself and assistant it was demonstrated to have been caused by some other agent. There was no current on the premises at the time of the fire or all during the night previous, nor was there a wire anywhere in proximity to the point at which it started.

The fire in Shea's Theatre was positively stated as having been caused by lighting wires. The indications are that it was not.

At this point the speaker explained that investigation had since pointed to the fire as having originated from some overhead wires, belonging presumably to signal systems, which became crossed with some heavily charged overhead circuits, and were melted at a point over the roof, igniting the same.

The cause was assigned to the fact that what is technically known as an "open fuse" was located in the dome between the roof and the ceiling, and that this fuse "blew," igniting surrounding shavings. In the first place, the fuse did not "blow," for the simple reason that in "blowing" it would have extinguished all the dome lights, and, as they were not extinguished until turned off in the usual manner by the stage manager, this cause is exploded. As all other evidence was totally destroyed, it is a "wild guess" and nothing more.

Next comes the burning of McIntosh's big grain mill at the foot of Princess street. Electric wires received due credit for this. The facts are that electric wires were not concerned in the fire, because the company had no electric light service from outside, but generated their own power, and this power had been shut down for some hours before the fire started.

Take the great Simpson fire—electric wires were charged with this offence. At the time of the Simpson fire, viz.: early on Sunday morning, the very electric light service was "dead." It was the one time during the whole week that the power-house took its well-earned weekly rest. It was not running, and had not been running for some hours.

The great fire of April, 1904, was also attributed to wires. Upon thorough investigation this was found to be wrong. The main line switch at the Currie Building, where the fire started, was off, and was found amongst the debris of the fire, somewhat charred and bent up, but "still open." And so it goes from fire to fire, evidence showing that many electric fires were not electric fires at all.

So far as the wiring of new buildings is concerned, the work is generally well done; but we are considerably behind in the art of good wiring, owing to the careless attitude of many architects and others, whose aim is to reduce the cost to a minimum. There is not much thought to the permanency of the wiring, the main object being to get the lights burning with a degree of safety which will pass muster; and in a few years it is battered to pieces and becomes a menace to the city. The wiring that prevails here is what is known as knob and tube work, while in other large cities conduits are looked upon as being not only the correct thing, but in many places are compulsory in certain districts. There is no wiring as safe as conduit work. This fact has been proven by all Underwriters' Inspections Bureaus on the continent. This brings us to another point, and that is the Fire Underwriters, whom everybody loves!

The general impression of this Association is that they are people who "raise rates," that being their one and only feature. Such, however, is a very distorted conception of this benevolent body. The Fire Underwriters have done a great deal to improve the conditions of cities and buildings, and their efforts have been enhanced and moulded into beautiful form by the greatest of professions, viz.: architects and engineers.

I am not an insurance expert, beyond the fact that I know that it is wise to insure, and I don't propose to elaborate on the Underwriters' Association; but I do wish to go into the relationship that should exist between this great institution and the architects, and also the municipality.

The Fire Underwriters have done more to elevate electrical wiring than any other agency. In the first place, the Underwriters have, after years of research and at great expense, formulated the "National Code," which is the very hub of electric work. Every municipality, engineer, architect and inspector relies on the Underwriters' rules. They are the only code rules, and as the insurance companies are the people whose pockets are most concerned, and who have always been behind all the making of these rules, they are the people who, if invested with civic backing and assistance, are best adapted to enforcing them, and are meeting with much support and gratifying results here and elsewhere.

In Toronto the inspection is carried out by myself and an able electrical assistant directly; and I have also the indirect assistance of several of our factory inspectors. I have also two in Hamilton, one in London, one in St. Catharines, one in Brantford, one in Woodstock, and have just appointed one in Ottawa, and it is likely that before long the system will be extended here.

Ontario is now so well covered that architects should provide for inspection and certificates in all places as well as Toronto. If architects, therefore, in drawing up specifications, would stipulate that the work must be not only up to our code rules, but must be mechanically executed in accordance therewith, they can rely upon good work.

Owing to the general lack of knowledge pertaining to electric work, architects have been guided too much by price. As a general rule the wiring in a building is com-

* Paper read before the Toronto Chapter of the Ontario Association of Architects.

paratively a small item, and I would urge upon architects the importance of calling for iron conduits in all buildings, and also to adopt or have instituted a district where only this class of work can be used. With iron conduits fire risk is reduced to the minimum, and the patching and interference of work by amateurs is largely prevented. In New York City nothing but iron conduits are allowed on Manhattan Island.

In awarding contracts for electric work it is advisable for architects to make enquiries before letting work to unknown wiremen. There are in Toronto electric firms whose policy is to do right, and who have the means and the knowledge necessary to do so. Then there are the firms who would do right, but have not the knowledge, and sometimes not the means. Then there are the people who have not the knowledge or the good intention. Look out then for this class of electricians.

There are contractors in this city who would not countenance any flaws for a moment, and such firms are to be trusted and encouraged in every way ;and, at this point, I might say that excellent men are to be found among the small men as well as with the large. Generally speaking, large firms are familiar with large work, and such are better equipped, financially and otherwise ; but then the small man sometimes only needs an opportunity. With a few exceptions the Toronto electricians are an honest and good class of men, always willing to stand to the rules ; but there are, of course, a few who simply "dabble" in it, and "know it all" ; and then there is the "amateur electrician," whose place is in a glass case. These amateurs have more knowledge and generally more to say than the combined experience of the profession, and, strange to say, often impress their hearers. I know of cases now where people entrust their electric wiring to these men, and often boys, foolishly imagining that they know more and are more competent than experienced professionals. I know of a large enterprise the managers of which engaged an expert of continental renown to design and execute some great electrical undertakings, but, before adopting his plans, submitted them to their local engineer and fireman to report on. The fireman received $2.00 a day, and the expert $100.00. What architects would award their painting to the plumber, or their plumbing to the bricklayer? Then by all means give electrical work to the electrical contractors. This is not intended to disparage the plumbing firms who have well-equipped and well-organized electrical departments, some of which are amongst the leaders in the trade ; but to advise against the sticking in of wiring anywhere so that whoever gets it farms it out to anyone, and often to some incompetent friend, who takes it at a price that he must either do it without wages or steal the material, this last fact being only too manifest to the trade.

Electric wiring is a trade, and should be recognized as such. We hear a lot about electric fires and yet, strangely enough, people will pay as little attention to who does their wiring as though they were awarding a contract for digging post-holes.

Speaking again of the so-called danger of wiring, I would not have my hearers go away with the idea that danger is an unknown quantity. There is danger in bad wiring, but in good wiring there is not, provided it is not tinkered with after completion. Let people who desire to make alterations and additions send for a capable electrician, or, under favorable conditions, keep one firm around their work. Let big firms arrange to have quarterly or other suitable periodical inspections, all of which we can and will undertake.

Scare talk is also an injustice to the local electrical supply companies, inasmuch as it frightens people from using electricity. I know of firms in Toronto to-day who are burning gas because they have been frightened from using electricity ; and, in such cases, they are living in a fool's paradise, because, under their circumstances, the gas is more hazardous. These people are scared to death by a phantom, whose visitations are the exception. If people desire to use electricity in any of its many beautiful and useful forms, let them demand an inspection from the underwriters, and they can rest at least as securely protected against fire as when using any other illuminant.

Many people burn coal oil because they are afraid of horrible dangers and inconveniences, and still continue to be undisturbed when the gruesome tales of lamp exsions and fires resulting therefrom are published, which reports are all verified, while electric fires are in most cases only assumed.

The greatest protection against electric danger, beyond that of good work, is to turn the current off when leaving the premises. Every building, store and dwelling in the city is provided with a "service switch." The simple opening of this switch will completely cut off the current, and the wires throughout the premises will be as harmless as they were when serenely coiled away in the warehouse before being put into commission. Let the nervous owner of a mill, warehouse or shop detail someone to see that the "main line switch" is pulled the last thing upon leaving the premises, and he can rest assured that no fires will start—from this cause anyway. Many people have never heard of or seen this "service switch," and many who have do not understand its functions.

Looking into figures, I find that of all the fires in the United States, reported as having originated from electric wires, upon careful investigation only 20 per cent. could be fairly attributed thereto.

I am not here to boom electric light, as one might infer, but, in justice to the trade and those directly interested therein, I hope I may be able to in some degree dispel a portion of the unnecessary alarm, and, if possible, present some facts in their true light.

In conclusion, there are some points I desire to bring before architects, and that is the provision for and proper installation of telephone and call-bell wires in office buildings and apartment houses. Danger is invited by the neglect of this point, as these wires are often strung into buildings in any way, regardless of safety or appearance, and it is time this point was seriously investigated. I would be pleased to furnish architects with the rules and specifications governing this work. The fact that these services do not in themselves carry any heavy currents is no guarantee of safety, because they can and do become conveyers of dangerous currents from outside lines, with which they may and do become crossed. This fact, together with the unsightly appearance they present around the walls and corridors of buildings, is sufficient reason why they should be looked after.

At the conclusion of the paper a hearty vote of thanks was given to the speaker, and some discussion followed. Conduits were considered the proper measure of safety for large and important work, and an ordinance requiring their insertion in a certain district was thought desirable. The question of inspection was also discussed, and it was agreed that the enforcement of the national code of rules would be a good thing.

The Armstrong Light & Power Company have submitted a proposition for electric lighting at Enderby, B C. They agree ofurnish 100 kilowatts for $135 per month, the Council to pole and w the municipality.

The electric light plant at Eglinton, Ont., broke down in January last, since which time the town has been in darkness. The lights were again turned on May 5th, the Stark Electric Light Company furnishing the power.

The Canadian Westinghouse Company, Limited, have been awarded a contract by the Montreal Street Railway Company for a large amount of apparatus. This was necessitated by the rapidly growing traffic of the company. The order included 20 quadruple equipments of 101-B railway motors complete with controllers and details; also a 1000 k.w. 600 volt, direct current engine type generator for installation in their main power house, and three 500 k.w., three-bearing, motor generator sets consisting of type C motors and 550-volt direct current generators. These latter are similar in capacity to those now installed in their various sub-stations, which feed directly into the trolley circuits.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Reversible Steam Turbine.—A recent issue of the Mechanical Engineer gives a description of a reversible steam turbine, in which the reversal is effected by two sets of vanes set on concentric circles with reference to the rotating shaft, one set of veins being so constructed as to move the shaft forward and the other so as to move it in the reverse direction. Leakage of steam from the various passages is prevented by means of light steel stampings used to cover annular openings in the stationary element into which it is admitted and, by its escaping through the narrow openings under the steel stampings, has its velocity so increased that leakage of live steam in the reverse direction is prevented.

Luminous Arc Lamp.—A paper presented before the Illuminating Engineering Society, in New York, by E. L. Elliott, brings out strongly the enormous light efficiency of the flaming or luminous arc lamp. Tests show that on the basis of spherical or total flux, a candle-power is produced on .353 watt, as compared with 1.78 watts for the enclosed arc light, 1.9 watts for the tantalum filament, and 3.9 watts for the ordinary (3.1 watts nominal) carbon filament. Other advantages of the lamp noted are the excellent quality of the light, both in color and steadiness, and its superior distribution. Aside from the present price of the lamp and electrodes, the main disadvantage is attendance due to the short life of carbons as compared with the enclosed arc.

Voltage Regulation.—A simple method of regulating the voltage in the distributing system of an alternating-current supply is described in Elektrotechnique Zeitschrift, of Berlin, by Herr Jacques Bubhi. The method is based primarily on the use of a special form of auto-transformer. This transformer has one section of the coil connected across the feeding main and the other section is connected between these mains and the distributing mains. The latter section of the coil is divided into several parts, which by means of asystem of switches may be cut in or out of circuit. By this means it is possible to alter the potential of the distributing mains irrespective of the varations on the transmitting mains. When passing from one tap of the transformer to another a reactance is introduced momentarily to prevent short-circuiting of the coil. The apparatus may be used on high-potential circuits. It has been constructed for a 15,000-volt system, the switches in this instance being of the oil-break type and are automatically connected in the proper series when the controlling handle on the switchboard is turned.

The Lorimer Automatic Telephone.—A new automatic telephone system, the Lorimer, is being developed on a principle differing from other automatic telephone exchanges that have been put on the market. In the Strowger system and developments from it, a step-by-step mechanism is needed for every subscriber's line, but in the Lorimer system the step-by-step device is associated with what corresponds to the operator's cords in an ordinary exchange. In this way the amount of complicated mechanism is lessened. At the exchange end of each line a device is necessary for the selection of a "cord", but this, we believe, is comparatively simple compared with the step-by-step mechanism itself. In the event of all the cords being engaged, the call is stored up, not at the exchange end but at the subscriber's instrument, until the connection can be effected. The idea is ingenious, but as in all such systems, it appears that there will be considerable complication in the case of large exchanges, and that junction work will hardly be feasible.

An Electric Safety Lamp.—A type of incandescent lamp designed to give as nearly absolute security against fires or explosions as possible has been devised by Dr. D. Tomassi, of Paris. The idea is to extinguish the lamp automatically should the protecting globe be broken and to prevent the flying of incandescent particles if the lamp globe itself should be shattered. The method of doing this consists in surrounding the globe of the lamp itself by a second glass covering fitted so as to be air-tight. Within this second globe is a switch which normally stands open, but which, when subjected to air pressure, closes the circuit and allows the lamp to light. The lamp is lighted by forcing air into the outer globe, in this way closing the switch. If, then, the outer globe be shattered, the reduction in air pressure which takes place immediately will extinguish the lamp before the inner globe is broken. If, on the other hand, the inner globe breaks, the reduction in pressure of the air in the outer globe due to collapse of the inner globe will open the switch and put the lamp out. In case of an accident of this kind the outer globe will of course stop all flying particles and prevent any fire.

The "Wolfram" Lamp.—A lamp, apparently destined to be called the Wolfram lamp, in which a filament of "wolfram" or tungsten is employed, is shortly to be brought on the market. This lamp is distinct from the one which is being developed by Dr. Kuzel, although tungsten is one of the metals which are mentioned in Kuzel's patent. It is the subject of a patent by Dr. Alexander Just and Franz Hanaman, of the Vereinigte Elektricitats-Werke (Budapest), and the German rights have been acquired by the Wolfram Lampen Aktiengesellschaft (Augsburg). We give the following particulars of the process of manufacture from the British Patent No. 11,949 of 1905.

Experiments, it is said, have demonstrated that when carbon filaments, which are provided with coats of wolfram (tungsten) or molybdenum of sufficient thickness, are submitted in highly rarefied gases or in vacuo, in order to prevent oxidation of the metal under

the action of the electric current, to an adequate temperature, the carbon combines with the metal surrounding it with the formation of a carbide. The carbon becomes completely dissolved in the metal in such a manner that a filament formed in accordance with this process is entirely homogeneous, so that, according to the patent specification, under the microscope no carbon core can be distinguished at the point of fracture. This process, which may be termed "dissolving" the carbon, occupies but a few minutes, and takes place the more speedily the greater the excess of metal above the carbon.

Carbon filaments of the greatest possible fineness (of a diameter of, say, from 0.02mm. to 0.06mm.) are submitted to the action of an electric current in an atmosphere of chlorides of wolfram or molybdenum (preferably WCl_6 = wolfram hexachloride, or molybdenum pentachloride = $MoCl_5$) in the presence of hydrogen or of some other gas exercising a reducing action, whereby the wolfram or the molybdenum is metalically deposited upon the surface of the carbon. When the metallic coating is of sufficient thickness, which may be ascertained by the current indicated by an ammeter (say 1 ampere when carbons of 0.04mm. diameter are employed), the filaments are brought to incandescence by an electric current in an atmosphere of very highly rarefied inert gases, such for example as hydrogen gas at a pressure of 20mm. The solvent process referred to above then takes place in a very brief period, a few minutes being usually sufficient. The filaments so obtained, which contain the carbon in a bound form (mostly as carbide) present a glittering white metallic appearance.

The incandescing filament is once more raised to a high temperature by an electric current in a mixture of steam with reducing gases, and the carbon is oxidized by a similar action to that which takes place in the manufacture of water gas. An alternative method given for the elimination of the carbon is to raise the incandescing filament to a high temperature in vacuo by the electric current for a long time (say 24 hours) in such a manner that the carbon volatilizes. Another method of decarbonizing described is as follows: The metal filaments containing carbide are embedded in a refractory crucible, which is then carefully luted in very finely pulverized low oxides of these metals, such for example as WO_2 or MoO_2, which is then submitted to the heat of a blast furnace (about 1600°C are required) for several hours. By this process the carbon is oxidized as indicated in the following equations: (1) $WO_2 + 2C = 2CO + W$; (2) $MoO_2 + 2B = 2CO + Mo$. The reduced wolfram or molybdenum does not become deposited upon the filament, but remains comprised in the oxide mass, because the wolfram or molybdenum upon reduction at this temperature surrounds the filament as an amorphous powder, without being deposited upon the same. As soon as this oxidation process is completed (in, say, from 10 to 12 hours) cooling is allowed to take place, and the crucible is opened.

The metallic filaments obtained by one of these processes may then, it is stated, be fused into the glass bulbs and employed for incandescent lamps without further treatment.

The electric light plant at Edmonton, Alta., is being extended.

VISIT OF ELECTRICIANS TO GREAT BRITAIN.

The following is an outline programme of the meeting in Great Britain of the Institution of Electrical Engineers and the kindred institutions of Canada, France, Germany, Italy, Switzerland, and United States—June and July, 1906:

JUNE 23RD AND 24TH—Central Committee Rooms at the Hotel Cecil will be open for registration of visitors and members.

JUNE 25TH—Afternoon. A visit to the National Physical Laboratory may be arranged, to attend the ceremony of opening the new Electro-Technical Laboratory. In the evening, reception and banquet at the Hotel Cecil.

JUNE 26TH—Visits to the General Post Office, power and electric lighting stations, railway and tramway power stations, engineering works, telephone exchanges, and other undertakings and places of interest. In the evening, conversazione at the Natural History Museum.

JUNE 27TH—Excursion up the Thames and visit to Windsor.

JUNE 28TH—Leave London for Birmingham District. The programme will include visits to works in and near Birmingham, including Rugby and Stafford. Arrive Manchester in the evening.

JUNE 29TH—Manchester District: Visits to electricity stations and works in Manchester, Salford, and the neighborhood. Conversazione at the Town Hall in the evening.

JUNE 30TH—Proceed to Liverpool. Visits to electricity stations, works, and railways. Leave in the afternoon for the Lake District (Windermere).

JULY 1ST—Excursions in the Lake District. Proceed to Glasgow in the evening.

JULY 2ND—Glasgow District: Visits to works and reception by Lord Kelvin.

JULY 3RD—Visits and excursions in the neighborhood of Glasgow.

JULY 4TH—Leave Glasgow for Edinburgh. In the afternoon leave Edinburgh for Newcastle.

JULY 5TH—Newcastle District: Visits to works and power station.

JULY 6TH—Leave Newcastle for Leeds. Visit to works and excursions in the neighborhood of Leeds.

JULY 7TH—Leave Leeds for London.

Entertainment will be provided in London and local centres for the ladies of the party and those of their friends who desire to accompany them.

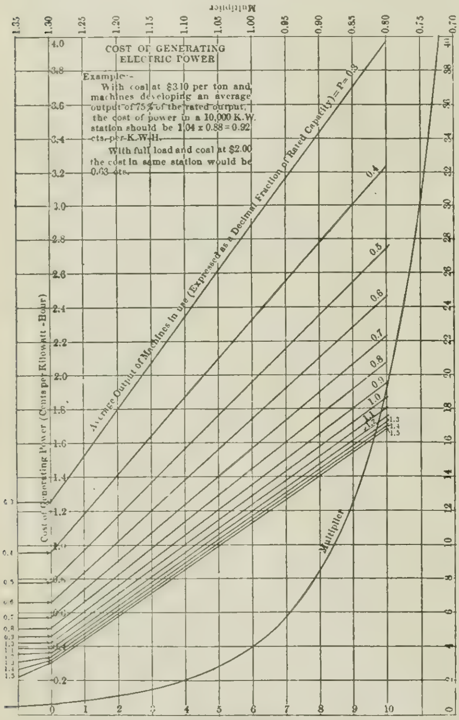
The headquarters in London will be at the Hotel Cecil. Guests are desired to call at the headquarters of the hotel as soon as possible after arrival in London for the purpose of registering their names, as tickets for the various excursions and functions will be distributed at these rooms. The rates at eight hotels conveniently situated for attending the proceedings range from five shillings per day upwards for single rooms. It is estimated that the expense of guests during their stay in London will be about \$5 each per day. Tickets for the Provincial Circular Tour will cost \$68, and persons intending to avail themselves of this tour are requested to send in advance a remittance to that amount.

The Mitchell Electric Company, Winnipeg, Man., have amalgamated with the Hudson Electric Supply Company.

COST OF GENERATING ELECTRIC POWER.

The cost of power is dependent upon so many variable and uncertain factors that it is impossible to arrive at any theoretical results which will be strictly applicable to individual practical cases, but it is possible by making certain assumptions to calculate a series of cost curves which will approximately represent the cost of power per kilowatt-hour under various conditions and whose relative values will be fairly reliable.

F. A. Griffin has followed this plan, and gives in the "Street Railway Journal" the following curve sheet from which may be found the cost of generating electric power in stations ranging in capacity from 400 KW. to 40,000 KW. The cost of power expressed by the curves is intended to represent the cost which can be obtained commercially in a well-designed station with a reasonably efficient operating staff.



CURVE SHEET FOR FINDING THE COST OF GENERATING ELECTRIC POWER.

The use of the curves may be illustrated by solving an example. Let it be required to find the cost of generating power at a station whose rated capacity is 10,000 KW., the average load on machines in use being 75 per cent. of their rated output and bituminous coal costing $3.10 per ton. Following up from the lower horizontal scale to a point about midway between the straight line marked 0.7 and the one marked 0.8 over the point corresponding to $3.10 per ton, the figure 1.04 is found on the left-hand vertical scale. Following to the left from the right-hand vertical scale along the 10,000-KW. line to its intersection with the curve marked "multiplier," the figure 0.88 is read upon the upper horizontal scale. The product of the two figures thus obtained, 1.04 times 0.88, gives 0.915 cent per kilowatt-hour as the probable cost of power.

If the average output of the machines in use is equal to their rated capacity, and coal can be had at $2 per ton, the cost of power would be only 0.63 cent per kilowatt-hour.

THE MOFFAT FUEL SAVER.

A company has been incorporated, with a capital of $100,000, to manufacture and place on the market the Moffat Fuel Saver. The president of the company is Mr. Newton J. Ker, city engineer of Ottawa, and the secretary-treasurer Mr. Walter H. Ostrom, also of Ottawa, the other directors being Messrs. A.W. Fraser, K.C., D'Arcy McMahon, J. G. Turrift, M. P., Alex. Fleck and R. C. Tate. Their head office is at 42 Central Chambers, Ottawa, and branches have been established at Quebec, Montreal, Toronto and Vancouver. The business will be carried on under the name of the Moffat Fuel Saver, Limited.

The Moffat Fuel Saver admits the oxygen required into the smoke at a temperature of over six hundred degrees, through air chambers having a series of intercommunicating compartments. The larger of these compartments is placed in the bridge wall, while the smaller is placed in an auxiliary bridge wall about 22 to 36 inches in the rear of the main bridge wall known as the baffle wall, and having an arched opening beneath, while at the rear of the boiler is placed a dead wall, these three walls combining to make a series of combustion chambers. Air is admitted to the bottom compartment of the air chamber, through a pipe or aperture which leads through the brick wall to the outer air. This pipe is opened and closed by means of a slide door. Apertures about an inch to two and a half inches in diameter, and 4 to 8 inches apart, are placed in the rear of the upper compartments of the two air chambers, to allow the air to flow into the combustion chamber, and corresponding apertures are left in the brick work of the bridge wall and baffle wall. The system in the bridge wall is placed within 7 to 10 inches of the bottom of the boiler, while the system in the baffle wall is built to within 3 to 4 inches of the boiler.

Entering the pipe leading to the air chamber in the bridge wall, the air travels from the lower compartments to the upper, attaining over six hundred degrees of heat. The air leaves the upper compartments through the openings in the rear, and encounters the smoke and gases as they flow over the bridge wall. As the heated air enters the smoke, a combustion is formed, the gases igniting and forming a hot blue flame which travels along the bottom of the boiler, and over the baffle wall. The heavier smoke containing the carbon strikes against the baffle wall and rebounds, intermingling with the air flowing from the system in the bridge wall. The carbonaceous particles take fire, and being heavier than the gases, fall downward, where they are drawn through the arch, into the second combustion chamber.

The air admitted to the smoke from the bridge wall system, however, is insufficient to consume all the gases and carbonaceous particles, and a further supply of air is necessary. This is admitted through the second system in the baffle wall. The portion of the gases and carbonaceous particles not consumed in the first combustion chamber, flow over the baffle wall, and through the arch into the second combustion chamber. Here it mixes with the fresh heated air flowing out through the openings in the rear of the baffle wall, and striking and rebounding from the dead wall placed at the end of the boiler.

A thorough commingling of the gases and superheated air occurs, and an almost perfect combustion is claimed to be formed, the gases being entirely burned and the carbon particles consumed.

The Blindman Electric Light & Power Company are likely to secure a franchise for electric lighting at Lacombe, Alta.

The directors of the Ontario Power Company are understood to have voted $2,500,000 for the immediate completion of the company's development plant at Niagara Falls. The company's franchise permits them to develop 180,000 electric horse-power, but the section of the plant which has been under construction for the past four years and is now nearing completion provides for only 50,000 horse-power. Three 10,000 horse-power generators are now running, a fourth is nearing completion, and the fifth is under construction. The full equipment will be eighteen generators, with a corresponding number of turbines of equal power.

TELEGRAPH and TELEPHONE

DEATH OF TELEPHONE PIONEER.

Mr. B. W. Chipman, President of the Nova Scotia Telephone Company, and Secretary of Agriculture for Nova Scotia, died at Halifax on April 24th. He was 70 years of age. In 1887 he was one of the principals in the organization of the Nova Scotia Telephone Company, of which he has been president since the death of W. C. Delaney, who was its first president. He has been Secretary of Agriculture for about 15 years.

GRAND TRUNK TELEPHONE SYSTEM.

Arrangements are being made by the Grand Trunk Railway Company for a telephone installation of their own over their entire system. The central exchange will be at the general offices of the company, where the switch-board, with all the necessary terminal facilities, will be erected, and the wire will run from Montreal to Portland on the one hand, and from Montreal to Chicago on the other.

This installation will mark an entirely new departure so far as Canadian railways are concerned. It is regarded as a highly important undertaking, involving an expenditure of between three and four hundred thousand dollars, and the construction of many thousands of miles of copper wire. It will be some time before the management will be able to begin the actual construction of the system, as the project is difficult and complicated and outside the ordinary lines of railway experience.

WIRELESS TELEGRAPHY.

Mr. W. Sloan recently had an interview with the Minister of Marine and Fisheries, and outlined his views as to the establishment of wireless telegraphy on the coast of British Columbia. He advocated three high power stations, located, one at Bamfield Creek, one in the vicinity of Cape Caution or Rivers Inlet, and the third at or near Port Essington or Port Simpson. These stations in a direct line would be some 250 miles apart, and would be in continuous communication with each other, and would cost in the neighborhood of $10,000 each. Mr. Sloan also advocates the establishment of some small power stations at suitable intervening points.

The C. P. R. have intimated their intention of installing the wireless system on their trans-Pacific steamers, and also on their coasting boats.

Hon. L. P. Brodeur promised Mr. Sloan that a substantial amount would be provided in the supplementary estimates for the purpose outlined.

TELEPHONE DEVELOPMENT.

Few people probably realize that the telephone business has been attended with more rapid development than either the telegraph or written letters. Yet, if some recent statistics bearing on the whole world are to be believed, this is what has occurred. In the ten-year period, 1904-1894, inclusive, the percentage of increase in the number of conversations over the telephone wires of Europe was three times as great as the percentage of increase in the number of letters and postals written during the same period. In the United States the ratio of increase in favor of the telephone has been even more remarkable. Taking the lines of the American Telephone and Telegraph Company alone, it is found that the percentage of growth in telephone conversations to letters and postals in the United States in the ten-year period mentioned has been as 4½ to 1. In both Europe and the United States the relative importance of letters and postals and telegrams as means of communication has diminished, while the telephone has increased in Europe from ten per cent. to over 18 per cent. of the total, and in the United States from 18 per cent. to nearly 38 per cent. of the total.

SHORT CIRCUITS.

The Bell Telephone Company have recently completed two additional copper circuits between Toronto and Hamilton.

The Home Telephone Company, of Portland, Oregon, are said to have decided to again make application for a telephone franchise at Vancouver, B.C.

The Bell Telephone Company at Kingston, Ont., have moved into their new exchange on Clarence street. The exchange has been equipped with modern apparatus and is now one of the most complete in the province.

The Canadian Machine Telephone Company, of Peterboro, Ont., are reported to have secured the contract for installing an automatic telephone system at Edmonton, Alta., Mr. R. S. Kelsch, of Montreal, being the consulting engineer of the work.

The number of Bell telephone exchanges in Canada in January, 1905, was 490, having connected to them in round numbers 77,000 telephones. Montreal, with a population of 267,720, had 14,995 telephones, and Toronto, with 208,040 inhabitants, came next with 12,714.

The Dinorwic & Gold Mines Telephone Company, Limited, has been incorporated, with head office in Toronto, to construct a telephone system in the district of Rainy River, Ont. The capital is $40,000 and the incorporators include Messrs. Anthony Blum, of Brookline, Mass.; H. W. Scattergood, of Philadelphia; J. G. Shaw and Joseph Montgomery, of Toronto, and others.

The Bell Telephone Company are seeking a five-year renewal of their exclusive franchise at Ottawa. It is understood that they agree to pay $5,000 annually to the city, the price for business phones to be $45 and for house phones $25. With two parties on one wire the rate would be $36 for business and $20 for house instruments. The city now gets $2,500 a year, while the rates are $25 and $45 respectively.

The Grand Trunk Pacific Railway telegraph work, under the energetic direction of Mr. A. Bruce Smith, manager telegraph department, is progressing rapidly. Already 30,000 cedar poles contracted for are being delivered at the company's storage yards at Fort William and Portage la Prairie. Materials for erection of the first 1,000 miles of wire are also being delivered. Organization is about completed to begin active construction as soon as the frost is out of the ground.

An Ontario charter has been granted to the Low Banks Telephone Company, Limited, with head offices at Low Banks. The provisional directors are Messrs. Alvin Barrick, J. E. Furry and Archibald Mann and the capital is $40,000. The charter allows the company to operate in the townships of Humberstone and Wainfleet, in the county of Welland, and in the townships of Sherbrooke, Moulton and Dunn, in the county of Haldimand. The district to be covered lies between Port Colborne and Dunnville.

David C. St. Charles, an engineer of San Francisco, has invented a repeater which he claims will make it possible to telephone great distances. What the so called repeater has done for telegraphy, St. Charles' invention, it is claimed, has done for the telephone. The combining of the echo in nature with the sounding board of a violin furnished the clue to the discovery according to a statement of St. Charles' superintendent, Mr. John Glass, who is quoted to the effect that the invention is a success.

MONTREAL

Branch Office of CANADIAN ELECTRICAL NEWS,
Room B34 Board of Trade Building.

May 9th, 1906.

Messrs. Fogarty Brothers, St. James street, Montreal, have assigned, another evidence of the fact that the electrical business requires to be done on a higher percentage of profit than other businesses to be reckoned on a stable foundation.

Current was turned on for the first time by the Westmount municipal plant on Saturday, April 21st. Although the actual plant is not complete, a temporary General Electric alternator has been installed so as to take care of customers who move to Westmount at the usual period of removals in this section of the country, viz., May 1st. It now remains to be seen how long the various municipal councillors will keep their fingers out of the pie and let it run in a business manner, or interfere and make a mess of it.

Sohmer Park (so well-known to some of our Toronto friends) will have a strong competitor this year in the shape of Dominion Park, a new resort further down the river shortly to be opened up. Electricity will be by far and away the largest feature, being used for scenic railway and other power purposes, not to speak of the fact that some 30,000 incandescent lamps will be perpetually in evidence. The Montreal Light, Heat & Power Company have already laid several tons of copper in order to carry the current required for electrical purposes at this park.

An Automobile Show was held here last month, but the "Electrics" were not much in evidence. To give satisfaction on the hills in and around Montreal is a problem that will give the storage battery manufacturers some hard thinking.

A United States technical contemporary publishes an able article stating that some businesses have been ruined by lack of system, whilst others have piled system upon system to such an extent that it has become "Red Tape" and is a hindrance to their business. The writer thinks that this is not only confined to electrical operating companies of various sorts, but also to manufacturers of electrical apparatus and supplies. Is this not a timely warning?

WESTINGHOUSE CONTRACTS.

The Canadian Westinghouse Company, Limited, have secured several important contracts recently, among which the more interesting are as follows:

One for supplying the Provincial Light, Heat & Power Company with apparatus to be used in the development of another large water power plant near Montreal. The initial installation will consist of three 3,750 k.w. revolving field, alternating current, water wheel driven generators of 4,000 volts, three phase, 7,200 alternations; also twelve 2,500 k.w., 44,000 volts, oil insulated, water cooled transformers. This new power station will be used for supplying additional power to the Montreal Light, Heat & Power Company at Montreal. The step-up transformers will be wound for 4,000 to 44,000 volts, and the lowering from 40,000 to 12,500 volts. The transmission line is about 40 miles in length.

Another is for the Northern Electric & Manufacturing Company, of Montreal, for a 300 k.w., Westinghouse-Parsons turbo generator unit, to be installed alongside one of the same capacity now in service. The generator is a 220 volt, three phase, 7,200 alternation machine, operating at 3,600 r.p.m., and will be of the latest enclosed type, while the turbine will operate at 150 pounds steam pressure with 100 degrees superheat. Their present turbine is operating part of the year condensing and through the winter non-condensing, the exhaust steam being used during the winter for heating purposes. It was the splendid operation of this steam turbine generating unit which led the company to order the one about to be installed.

The Yukon Consolidated Company have placed a contract for the following: Three 100 h.p. 3-phase, 60 cycle, 400 volt, tpe F motors; three 15 h.p. 3-phase, 60 cycle, 400 volt, type F motors; three 50 h.p., 850 r.p.m., 3-phase, 60 cycle, 400 volt, constant speed induction motors; three 30 h.p. motors; three 20 h.p., 1,120 r.p.m. motors; three 15 h.p., 850 r.p.m. motors; three 7½ h.p., 1,700 r.p.m. motors; nine 75 k.w., oil insulated, self cooling transformers; two 625 k.w., 3-phase, 60 cycle, 2,200 volts, 415 r.p.m., A. C. generators, and two 17 k.w., type S exciters for same; one 4 panel switchboard for controlling the above; four 250 k.w., oil insulated, oil-cooled transformers and four 200 k.w. transformers, same type.

PERSONAL.

Mr. E. R. Clarke, hydraulic engineer, has severed his connection with the Canada Foundry Company and gone into business for himself, having become associated with Connor, Clarke & Monds, consulting engineers, 36 Toronto Street, Toronto.

Mr. Matthew A. Sammett, of Montreal, is spending a good deal of time recently at Peterboro in connection with official acceptance tests of electrical apparatus for the Kaministiquia Power Company. The electrical apparatus is being manufactured by the Canadian General Electric Company on Mr. R. S. Kelsch's specifications, and consists of two 3750 k.w., 3-phase generators, exciters, step-up and step-down transformers and switchboards for power house and substation.

Messrs. E. H. Keating and D. J. Russell Duncan announce that they have opened offices at the Home Life Building, Victoria street, Toronto, and will carry on business as civil engineers under the fim name of Keating & Duncan, special attention being given to hydraulic, municipal, electrical and industrial undertakings. They are advisory engineers to the Monterey Railway, Light and Power Company and the Monterey Waterworks and Sewer Company, Monterey, Mexico.

Mr. F. Hoffmeister has completed the installation of the electric light plant at Indian Head, Sask., and is about to become associated with the work of installing the machinery in the power house of the Electrical Development Company at Niagara Falls. Before leaving Indian Head he was banquetted by the Town Council and presented with a gold watch in recognition of the satisfactory manner in which the plant had been installed. Indian head now possesses a plant which, for its size, is second to none.

The gas fellows aren't sleeping.

One of the latest is competition for the electric push button.

You can push a button by the door and light the gas burner in the chandelier.

It's pneumatic—not electric.

Yes, they're busy—are you?—The Booster.

CANADIAN ELECTRICAL NEWS AND ENGINEERING JOURNAL

VOL. XVI. JUNE, 1906 No. 6.

NIAGARA FALLS—ONE OF THE GREATEST WATER POWERS IN THE WORLD.

The C. E. A. Convention at Niagara Falls

The Local Committee, acting in conjunction with the Executive Committee, have now completed the arrangements for the sixteenth annual convention of the Canadian Electrical Association, to be held at Niagara Falls, Ont., Tuesday, Wednesday and Thursday, June 19, 20 and 21. The success of the convention now depends largely upon the members. Present indications, it may be said, point to a large attendance and the best meeting in the history of the Association.

Unfortunately, the new Clifton House, where it was proposed to have the convention headquarters, will not be completed in time, and it has therefore been found necessary, as the only alternative, to hold the business sessions at the International Hotel on the American side, where splendid accommodation will be provided.

MR. A. A. WRIGHT,
President Canadian Electrical Association.

The papers to be presented at the convention are as follows:

"Steam Plant Accessories," by John T. Farmer.

"The Power Plant of the Electrical Development Company of Ontario," by F. O. Blackwell.

"The Electrical Plant of the Canadian Niagara Power Company," by H. W. Buck.

"The Plant of the Ontario Power Company," by V. G. Converse.

"Some Legal Propositions of Interest to Electrical Men," by Robert McKay.

The names associated with the papers are a guarantee that the subjects of which they treat will be handled in an interesting and instructive manner. It is also fortunate that the members will have the opportunity of inspecting the three great hydro-electric plants described in these papers.

For an electrical convention, perhaps no place in the world compares with Niagara Falls. Always possessing a magnetic attractiveness for the visitor, it is of peculiar interest to the electrical man at the present time on account of the vast extent of the power development works under way, totalling more than 300,000 horse power on the Canadian side alone. The opportunity of visiting these magnificent plants, embodying the most modern engineering features, is one which should appeal to every member of the Association.

According to the programme, the first business session will be held Tuesday afternoon. Business sessions will also be held Wednesday and Thursday mornings, leaving the afternoons for visiting the power plants and for entertainment. A business meeting will also be held Tuesday evening.

The usual arrangements have been made with the railways for a reduced fare. Delegates should purchase a one-way ticket at the regular rate and secure from the ticket agent a standard certificate, which will entitle them to a return ticket at one-third fare. It is expected that a representative of the railways will be at the convention headquarters Wednesday afternoon to sign the railway certificates, which should be in the hands of the Secretary by that time. Badges should be obtained from the Secretary immediately upon arriving at the convention.

The Local Committee, consisting of Messrs. R. B. Hamilton (Chairman), J. W. Campbell, J. A. Kammerer, N. S. Braden, Geo. T. Rough, and others added to the original number, have arranged several attractive features and promise to leave nothing to be desired in the way of entertainment.

The programme, as arranged at time of going to press, will be as follows:

TUESDAY, JUNE 19TH.

1.15 P.M.—Executive meeting.
2.00 P.M.—Welcome by Mayors of Niagara Falls, N. Y., and Ontario.
2.30 P.M.—President's Address.
3.00 P.M.—Illustrated Paper by Mr. V. G. Converse, "Engineering Features of Ontario Power Company's Plant."
4.30 P.M.—Question Box.

EVENING SESSION:

8.00 P.M.—Illustrated Paper by Mr. F. O. Blackwell, "Engineering Features of Electrical Development Company's Plant.
9.00 P.M.—Illustrated Paper by Mr. H. W. Buck, "Engineering Features of Canadian Niagara Power Company's Plant, as compared with original plan on American Side."

WEDNESDAY, JUNE 20TH.

MORNING SESSION:

10 A.M.—Paper by, Mr. Robert McKay, "Legal Points of Interest to Electrical Engineers."
Question Box.

AFTERNOON SESSION:

Visits to Power Plants on Canadian Side.

EVENING SESSION:

8.00 P.M.—Gorge Trip.
10 P.M.—Smoking Concert.

THURSDAY, JUNE 21ST.

MORNING SESSION:

10 A.M.—Paper by Mr. J. T. Farmer, "Steam Plant Accessories."
Unfinished Business.
Election of Officers.

AFTERNOON SESSION:

Visits to Power Plants, and other attractions.

The Sunbeam Incandescent Lamp Company of Canada have been compelled, owing to the growing demand for their lamps, to double the capacity of their factory at St. Catharines, Ont. This is now under way, and in addition other improvements looking to the perfecting of the process of manufacturing electric lamps are being carried out.

ELECTRICAL TRADES EXHIBITION.

For the second time in the history of Canada, Montreal is to have an Electrical Trades Exhibition, which will be held under the auspicies of the Electrical Contractors' Association in the Victoria Rink, Montreal, from the 17th to the 22nd of September inclusive. The Managing Committee consists of Mr. E. W. Sayer, chairman ; Messrs. W. B. Shaw, F. J. Parsons, N. W. McLaren and W. J. O'Leary, with Mr. A. N. Gould, secretary.

The aim of the Managing Committee is to bring together under one roof a thoroughly comprehensive exhibit of the wonderful inventions and appliances of the electrical world. Diploma awards will be given for the best exhibit and for the most useful invention shown. Prof. Owens, of McGill University, has been decided on as the Chairman of the Judging Committee. Two other judges will be elected by ballott on the opening day from a list of ten names nominated by the exhibitors. This Judging Committee will make all the awards.

The Exhibition Hall has been divided into a hundred spaces, ranging in price from $50 to $125. A number of these spaces have already been taken.

Some of the rules governing exhibits are given below :

RULES.

All exhibits must be in place, properly connected and ready for the opening of the Exhibition by September 16th, 1906, at midnight.

Goods cannot be sold from the booths for cash, but orders may be taken and turned over to the consumer's contractor, or to the contractor direct.

No space taken in the Exhibition can be sub-let without the consent of the Chairman of the Exhibition Committee.

Exhibitors will have one week preceding the date of the opening of Exhibition in which to instal their exhibits, and four days after the closing of the Exhibition in which to remove their exhibits.

The Management furnishes the light for the hall proper, but exhibitors will be required to furnish any extra lighting they may need.

All booths are to be erected and decorated at the expense of the exhibitor. Spaces will be staked off only by the Management.

All exhibitors and their attendants will be furnished with a special badge.

The members of the Managing Committee will wear silver badges to facilitate exhibitors in locating those in authority.

The Exhibition Building will be a bonded warehouse during the Exhibition and goods will be entered free of duty if such goods are not sold during the Exhibition. The goods intended for the Exhibition must be shipped in the name of the firm or corporation shipping and must be marked "For Exhibition Purposes Only," and invoices must be shipped in duplicate with certificate attached (Exhibitors in the United States must use certificate Form M.) to M. Davis & Co., 25 Common St., Montreal, Canada, who have been appointed Custom House Brokers for the Exhibition.

All articles are there at exhibitor's risk, but Committee will have watchmen on duty at all times.

Exhibitors will make their arrangements about insurance, as the Management will not be held responsible in any way as regards fire or other losses.

THE EXPORT OF ELECTRIC POWER.

An Act received its first reading in the Dominion Parliament last month to prohibit the export of electric power excepting under special license. The main clauses of the Act are as follows :

"No person shall export any power or fluid without a license, or any power or fluid in excess of the quantity permitted by his license, or otherwise than as permitted by such license : Provided that any person who, immediately prior to the passing of this Act, is lawfully engaged in the exportation of power or fluid, shall not with respect to such exportation be subject to the provisions of this Act until....months thereafter, or until he has sooner obtained a license under this Act ; and provided that his exportation does not at any time during the interval rateably exceed in quantity of power or light the amount which he was exporting prior to the passing of this Act.

No person shall, without a license, construct or place any line of wire or other conductor for the exportation of power, or any pipe-line or other like contrivance for the exportation of fluid.

Subject to any regulations of the Governor in Council in that behalf, the Minister may grant licenses, limited as to quantity and subject to such conditions as he thinks proper, for the exportation of power or fluid, and such licenses shall be revocable upon such notice to the licensee as the Minister deems reasonable in each case.

Subject to any regulations of the Governor in Council in that behalt, the Minister may grant licenses for the construction, placing or laying of any line of wire or other conductor for the exportation of power, or of any pipe-line or other like contrivance for the exportation of fluid."

The bill was not discussed in the House at great length and it was subsequently withdrawn in deference to the wishes of the Ontario Government. It is expected that the question will be considered at a conference this summer between representatives of the Dominion and Provincial Governments, and the postponement of action in the meantime can do no harm.

MARITIME ELECTRICAL ASSOCIATION.

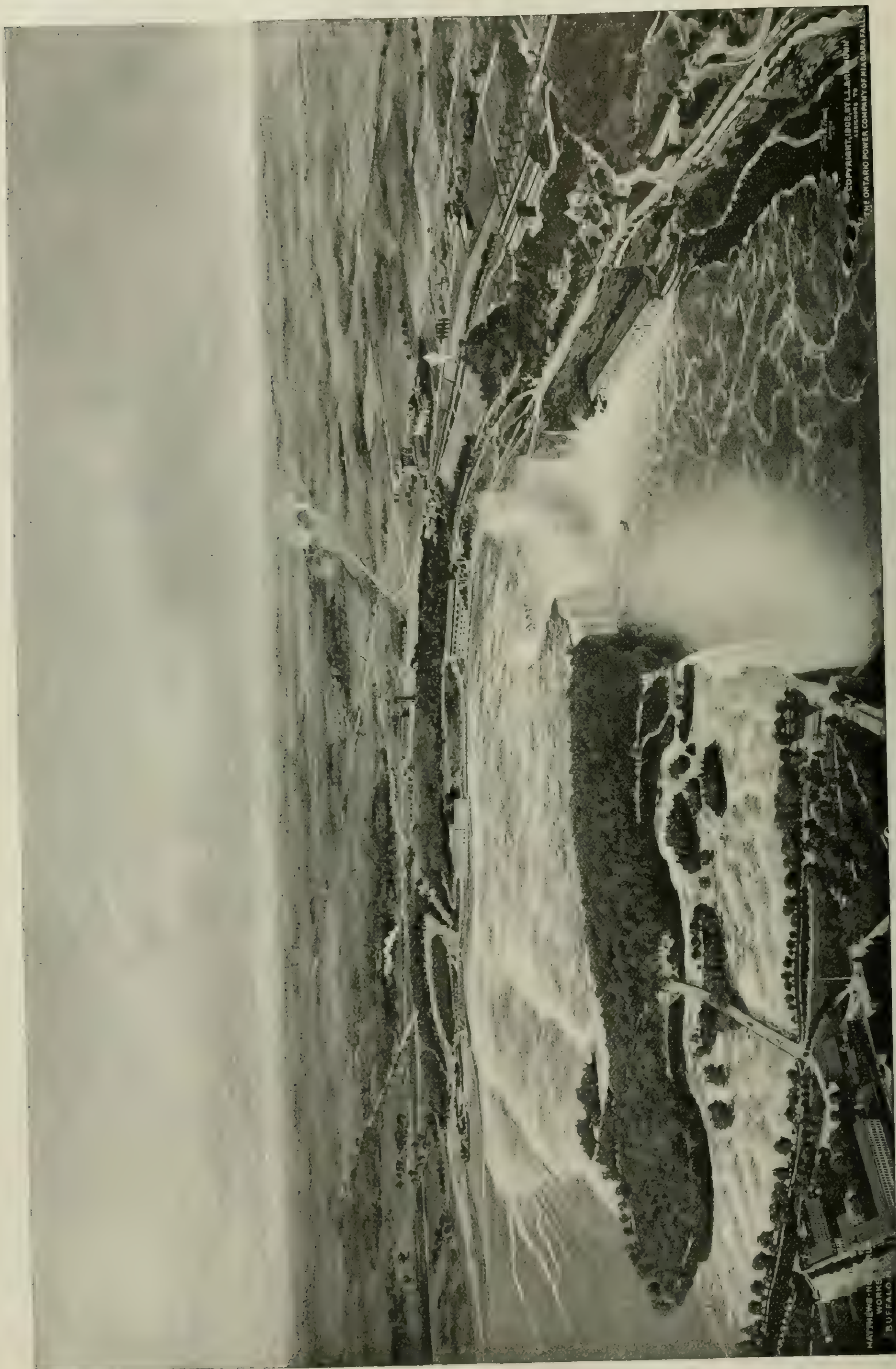
The Executive Committee of the Maritime Electrical Association have accepted the invitation of the Cape Breton Branch to hold the Summer Convention at Sydney, C.B., on the 18th, 19th and 20th of July next.

The Committee is desirous that all the members will endeavor to attend this convention, in order to make it as successful as possible. Further information in regard to programme, etc., will be given later.

INSPECTION OF ELECTRIC WIRING.

Referring to the letter in the May number signed, "Electrician", the Electrical News has since interviewed the Electrical Inspector of the Underwriters in reference to the same. Mr. Strickland claims that it is unfair to expect the Underwriters to maintain an inspector, to say nothing of his office and other expenses, for the benefit of the citizens of any particular place. While no doubt the inspection does benefit the insurance companies, he points out, in fairness to the Underwriters, that the inspector is called upon to inspect risks where there is no insurance and also many risks which are insured in non-tariff companies, in which the Underwriters are not interested. He is also expected to act as arbitrator between architects and contractors, to give all kinds of advice and to generally look after the interests of the whole city in reference to electric wiring. It is customary all over the American Continent and in most of the European cities to charge a small fee for such service, and he does not see anything unreasonable in it. In most states where they have a civic inspector, fees are charged also.

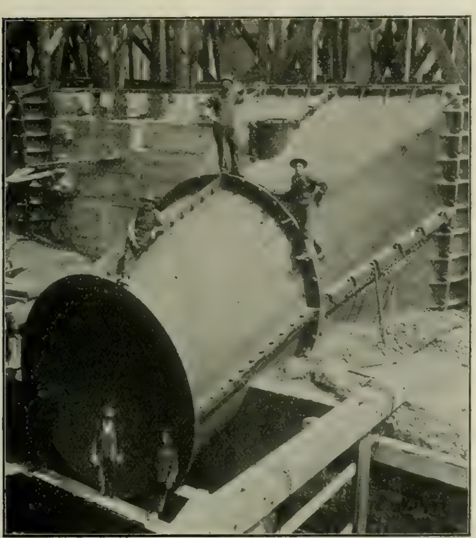
Mr. N. S. Braden, sales manager of the Canadian Westinghouse Company, recently spent a few days in Winnipeg while on a business trip through the West. He visited Edmonton, Vancouver, Seattle and San Francisco before returning to Hamilton.



BIRD'S EYE VIEW OF NIAGARA FALLS, SHOWING POWER DEVELOPMENTS ON THE CANADIAN SIDE.

The Electrical Development Company of Ontario

The last company to commence operations towards the development of electric power on the Canadian side at Niagara Falls was the Electrical Development Company of Ontario, Limited, the officers of which are as follows: President, Col. H. M. Pellatt; 1st vice-president, Frederic Nicholls; 2nd vice-president, Wm. Mackenzie; manager, H. H. Macrae; secretary, H. G. Nicholls; treasurer, D. H. McDougall. These gentlemen, with Hon. Geo. A. Cox and James



Electrical Development Company—From West Side of Wheel Pit, Showing Intake Castings, Unit 3, in Position.

Ross, comprise the directorate. The chief consulting engineer is Dr. F. S. Pearson; chief hydraulic engineer, Hugh L. Cooper; and chief electrical engineer, R. C. Brown.

The preliminary work was commenced in the spring of 1903. The development differs in many ways from any of the others on either side of the line, and the method of construction has called for engineering of very high order. The plant stands as a striking example of the mastery of man over Nature, for all the works have been practically constructed on what was previously the river bed. This made it necessary to unwater about twelve acres of the river.

That the magnitude of the undertaking may be understood we give the main features of the plans of the company:

Horse power being developed, 125,000 horse power.

Length of main tail race tunnel, 1,935 feet.

Length of subsidiary tunnels, 550 feet.

Height of main tail race tunnel, 26 feet.

Length of wheel pit, 416 feet.

Depth of wheel pit, 144 feet.

Length of power house, 500 ft.

Generators, eleven revolving field type of 12,500 horse power each.

The crib work cofferdam built to unwater the forebay was located in the midst of the Niagara river, where there was found to be a depth of water of 26 feet, which rendered construction most difficult. Where the work had to be carried on at right angles to deep water, flowing at a high velocity, the danger was very great. A platform was suspended out for sixteen feet from the end of each last crib, and standing on this the engineers had to sound every inch of the river bottom with an iron rod, the cribs being built to fit afterwards. An idea can be gained of the force of the water when it is mentioned that frequently the sounding rod was bent almost at right angles. To break the force of the current a fender of heavy timbers, held in position by three steel cables from some works higher up the river, projected out beyond the last crib in place.

In the design of the tunnel consideration was given to the fact that the Horseshoe Falls are constantly receding. The lining for the first three hundred feet from the outlet was put in in rings of six feet long, so that as the Falls recede and the tunnel shortens by the breaking away of the surrounding rock the lining will break away in clean sections and leave a smooth surface at the new end of the tunnel. This will also prevent the cracking of the lining back of the point where the tunnel breaks away. For the rest of the distance the lining is of hydraulic pressed brick.

The engineers consider that the plan of the tunnel, being quite straight, will prevent any special erosion of the surface of the lining which would be brought about by a change in the direction of a large body of rapidly moving water. The temperature in the tunnel is about 60 degrees, and does not vary.

The water will be discharged through steel draft tubes to two branch tail-race tunnels connecting with the upper end of the main tail-race tunnel. This design is a departure from previous practice. By the use of the two branch tail-race tunnels, it will be possible at any time to close down one-half of the station and make any necessary repairs without the other half of the station being interfered with.

Electrical Development Company—View from Coffer Dam, Showing Excavation in Forebay and Outer Row of Submerged Masonry Arches.

The gathering dam will ensure a supply of close on 2,000,000 cubic feet of water per minute, the needs of the plant being estimated at 700,000 cubic feet. The water thus gathered will be conveyed through steel penstocks to the water wheels, and the differences of level provided by the design are such that, after deducting losses from friction and the velocity of approach and discharge, there will remain an operating head of 143 feet to be used by the turbines. This wheel-pit is provided with masonry lining.

The wheel-pit is about 2,000 feet above the crest of the Falls. It is 416 feet long and about 22 feet deep, the bottom on which the turbines will rest being about 150 feet below the original surface. One of the illustrations shows the first draft tube elbow completed in the pit.

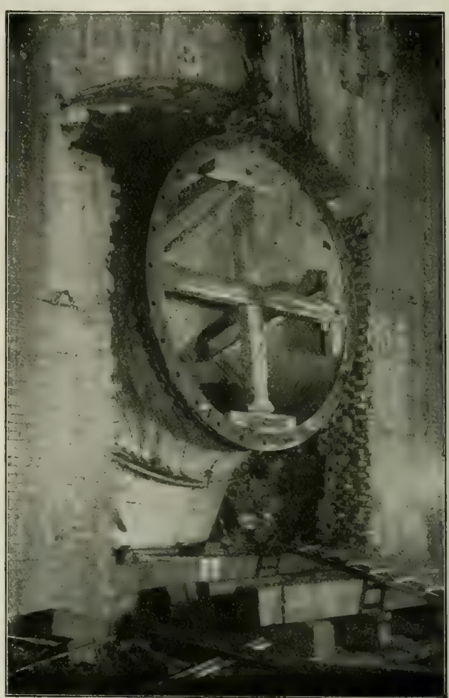
The water wheels, supplied by the I. P. Morris Company, are of the Francis type.

Of the eleven generators provided for in the complete plans, four are now being installed. They are built on masonry foundations at the level of the power house floor, and the connections between the generators and the turbines are made by the use of vertical shafts having a total length of approximately 150 feet supported at three intermediate points by solid masonry bearings.

The generators, which are being furnished by the Canadian General Electric Company, are of 8,000 k.w. capacity and present many new and interesting features of construction. We are pleased to be able to furnish the following particulars regarding their design and construction.

The generator is of the stationary armature and revolving field type, and arranged for direct connection to the vertical shaft of a 12,000 h.p. turbine. The armature and revolving field hence lie in a horizontal plane at right angles to the turbine shaft, the latter forming a rigid connecting link 150 feet in length between the turbine wheel and the revolving field, the former located at the bottom of the shaft and the latter on the power house floor at the surface.

The generator has a capacity rating of 8000 k.w. when operating at a speed of 250 r.p.m., this output being three phase current at a potential of 12,000 volts and a frequency of 25 cycles per second, full load current being 386 amperes per phase. The generator is provided with two bearings carried by spiders attached to the stator frame, one above and the other below the revolving field. The shaft of the turbine passes through the lower bearing and is coupled to the generator shaft between the lower bearing and the field



Electrical Development Company—In Wheel Pit, Showing First Draft Tube Elbow Completed in Pit.

spider, the generator shaft revolving in the upper bearing. The entire weight of the revolving parts, consisting of the turbine wheel, the shaft, and the revolving field, is carried by the thrust bearing of the turbine.

The generator proper with its bearing is mounted on a circular bedplate set on masonry. By this construction the generator as a whole becomes adjustable upon the bed plate, which enables it to be readily lined up with the trubine shaft.

The armature core is designed in accordance with the most recent engineering practice to best meet the function of supporting and protecting the windings as well as providing the most effective ventilation.

The field spider is a single steel casting pressed on to the generator shaft by hydraulic pressure and securely keyed in place. The field windings consist of bare copper ribbon wound on edge, insulated between turns and from the pole pieces by insulating material, leaving the outer edge of the winding ex

Electrical Development Company—In Main Tail Race Tunnel, Showing Intersection of Branch Tunnels.

posed to the air. The complete coil is firmly clamped between the pole tip and the field ring in such a way that it will be unaffected by either vibration or centrifugal force.

The shaft consists of a hollow steel casting 15 inches in diameter with a central hole 8 inches in diameter. The couplings at both ends are forged on the shaft, and are drilled to mate with the turbine and generator couplings respectively.

The great size and weight of this type of generator rendered it necessary from transportation considerations to ship the machine unassembled, this involving practically the complete assembling of punchings and winding at the power house.

Electrical Development Company—At North End of Forebay, Showing Excavation in Forebay.

The following data on weights may prove of interest.

Weight of stationary armature, complete with windings and bearings, with accessories	194,317 lbs.
Weight of the revolving field with accessories, including generator shaft	164,012 lbs.
Weight of base	28,030 lbs.
Total weight	386,359 lbs

For exciting the fields of the 8,000 k.w. generators both turbine and motor driven exciter units are provided in duplicate. Both types of units are of 300 k.w. capacity and designed to deliver their rated output at 125 volts when operating at a normal speed of 500 r.p.m. These units are of the vertical type and beyond special adaptation of bearing supports closely resemble standard types of apparatus.

The turbine driven units are, as stated, direct connected through a vertical shaft to individual turbines, the weight of the revolving parts being supported by the water thrust bearings of the turbines.

The motor driven units are direct connected to three phase induction motors of the squirrel cage rotor type. In common with the turbine driven units the bearings of these machines are designed for forced lubrication. For each motor-generator set is provided a three phase water cooled transformer of 380 k.w. capacity, arranged with low voltage taps for use in starting the induction motors, thus avoiding the necessity of providing starting compensators.

The power house switchboard is made up of seven a.c. panels, six d.c. panels and a controlling bench board extending the full length of the a.c. panels. Apart from the d.c. panels, three of which are arranged on either side of the a.c. panels and which control the output of the exciters, the power house board is primarily a controlling board for switches located both in the power house and the transformer station. Thus all of the switching mechanism is controlled completely from the bench board in the power house.

The panels and benchboard are located on a gallery provided for the purpose, while all bus-bars and power house switches are located in the basement. An interesting feature of the benchboard is the provision of a dummy bus-bar, which with the assistance of signal lamps enable the operator to clearly follow the various operations performed.

The power house of the Electrical Development Company, designed by Mr. E. J. Lennox, is of Italian Renaissance architecture and presents a very pleasing appearance. It is 500 feet long and 70 feet wide with an elevation of about 40 feet high, and built of Indiana limestone.

The switchboard will be located in the center of the power house. This, together with the water driven exciters and motor generator sets, will be installed immediately.

From the power house underground ducts will be laid to the transformer house, which is situated outside the park limits. It is designed to accommodate fifteen step-up transformers of an approximate total capacity of 40,000 k.w., of C. G. E. manufacture. These transformers will raise the voltage to 60,000, at which pressure it will be transmitted to Toronto over the line of the Toronto and Niagara Power Company, described elsewhere.

Electrical Development Company West Foundation of Power House, Showing Completed Foundations and Steel Erection.

Toronto Terminal Station of the Toronto & Niagara Power Company

The Toronto & Niagara Power Company have constructed a 60,000-volt transmission line from Niagara Falls to Toronto, a description of which will be found on another page. The two terminal stations, namely at Niagara Falls and Toronto, are in size, equipment and general arrangement, very similar and consequently a description of the Toronto station, which has been practically completed, will suffice.

The terminal or substation at Toronto is located on Davenport Road, just outside the city limits. It is 61 x 202 feet, two stories and basement, and is built entirely of steel, brick, stone, tile and concrete, with high ashar underpinning, brick walls pierced by numerous windows, and stone trimmings. The station is shown in Fig. 1. It is said to be the largest substation in point of capacity in the world and is to receive 30,000 k.w. at about 60,000 volts from Niagara Falls. Two of the four 60,000-volt circuits have been completed and a large part of the transforming equipment for these two circuits has been erected in the substation. Each circuit is to receive 60,000-volt, three phase, 60-cycle current and to deliver 10,000 electric h. p. with a line loss of less than 10 per cent.

FIG. 1.—TORONTO-NIAGARA TERMINAL STATION, DAVENPORT ROAD, TORONTO.

At this station the 60,000-volt current is transfor-

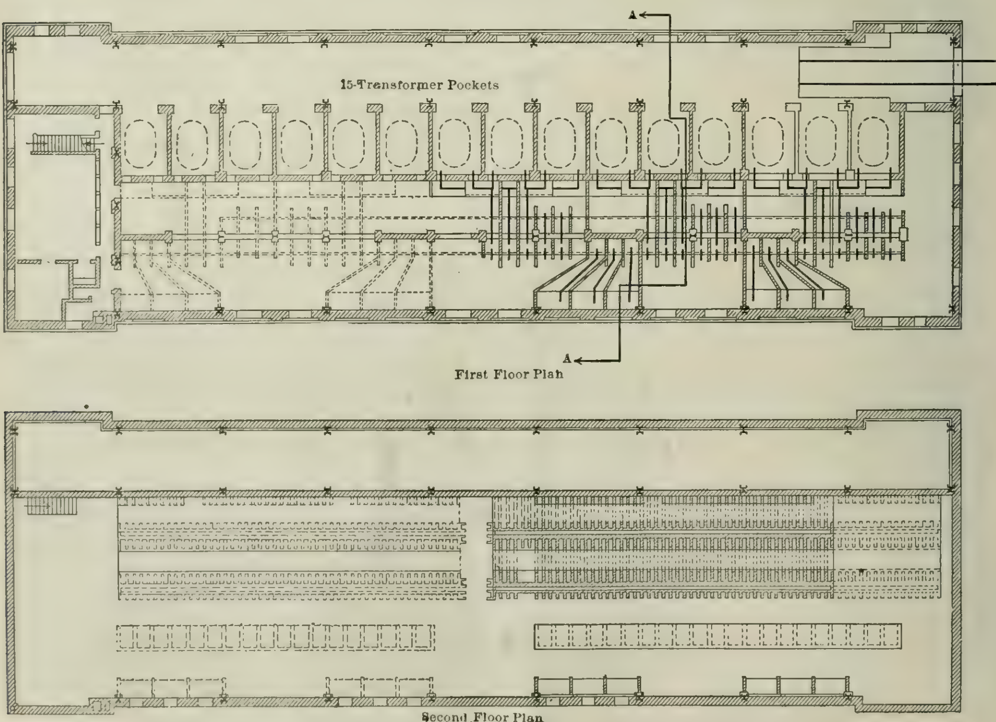


FIG. 2.—FLOOR PLANS, TORONTO-NIAGARA TERMINAL STATION.

formed to 12,000-volts, three-phase, for distribution to the several lighting and railway stations about Toronto.

Three transformers are provided for each transmission circuit and each of these transformers is rated to step down 2,000 k.w. of electric energy from 60,000 to 12,000 volts. For each transmission circuit the total transformer capacity at the terminal is thus 7,200 k.w. Though the four 60,000 volt circuits will be connected to only twelve of these 24,000 k. w. transformers at any one time, provision has been made at the Toronto terminal for fifteen units of this capacity, so that there will always be one set not in use. Each group of three transformers is connected in delta at both the 60,000 volt and the 12,000 volt windings, so that each transformer has the full line pressure at its high tension coils.

The current passes through a choke coil, current transformer, two 60,000 volt oil switches, 60,000 volt bus-bars, a step-down transformer, two 12,000 volt oil switches and 12,000 volt bus bars. Fig. 7 shows the 60,000 volt switches and Fig. 8 the 12,000 volt switches. On each side of each 12,000 volt oil switch and on each side of each 60,000 volt oil switch, except where a 60,000 volt oil switch leads directly to a transformer, there is a disconnecting switch in each conductor of each three-phase circuit, so that each conducter from the 60,000 volt entry to its transformer includes three connecting switches, and each conductor from its transformer to the 12,000 volt exit includes four such switches, by which arrangement each 60,000 volt transmission circuit may be directly connected with either group of three transformers alone, or may be connected to two or more groups of transformers in parallel.

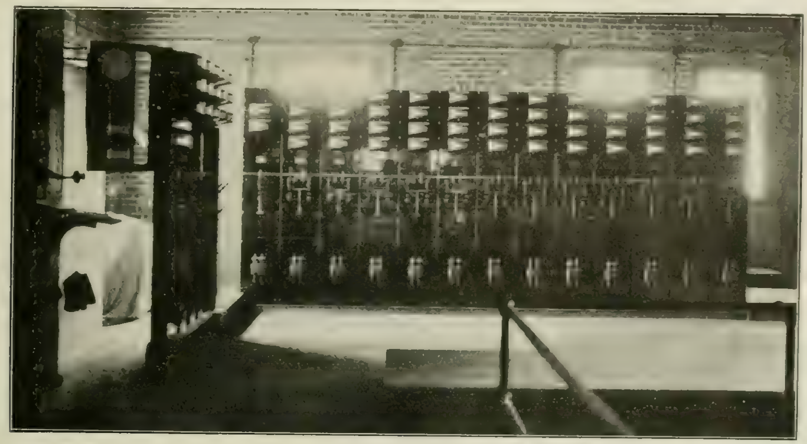


FIG. 3.—CONTROL SWITCHBOARD, TORONTO-NIAGARA TERMINAL STATION.

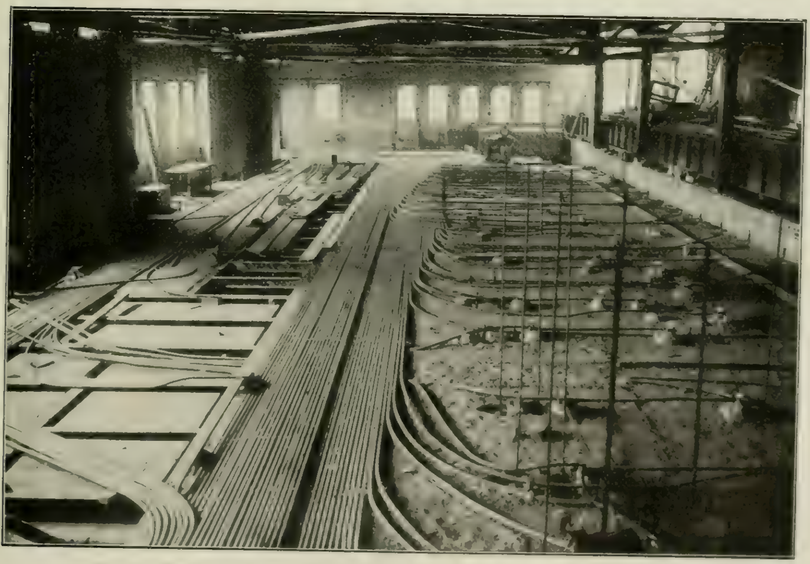


FIG. 4.—CONDUITS FOR CONTROL WIRES, TORONTO-NIAGARA TERMINAL STATION.

The lightning arrester to which each conductor of a 60,000 volt circuit is connected contains 240 air gaps between brass cylinders and 60 carborundum rods in series between the conductor and the earth and is mounted on insulators having three petticoats. The

current transformer, carried by each of two conductors in a 60,000 volt three phase circuit, is 6½ inches long and 6 inches in diameter in the enclosed part and has 16 inches between its high voltage terminals.

Switches designed to open a circuit carrying 7,200 k.w. at 60,000 volts are interesting. The Electrical World gives the following description of them : Each brick and stone compartment, in which the two oil cylinders carrying the terminals of one three-phase conductor are located, is 4.5 by 3 feet in floor area and 7.75 feet high, the fire brick partitions between the compartments being 8¼ inches thick. In front of each compartment there is an iron door hung at the top. Each compartment contains two cylinders mounted vertically in a common frame, and an end of one conductor of a three-phase circuit enters the bottom of each cylinder. These two cylinders and the frame that carries them are made of wood, save as to four porcelain insulators that unite the leg of the frame with the part that holds the two cylinders together. Heavy petroleum fills each of the wooden cylinders, and through a small central hole in its built-up cover plunges the vertical connecting rod that is electrically connected by a metallic cross piece with the corresponding rod of the twin cylinder. From this cross piece a vertical wooden rod rises through the stone top of each cell to the motor-driven operating mechanism above. In diameter each pine wood cylinder measures about 10 inches, and its length is 32 inches. Each pair of connecting rods for a conductor of a three phase circuit, in one of the 60,000 volt, 300 amp. oil switches, has a break or throw of 33 in., so that the conductor is opened by a total break of 66 in. From its oil switch each conductor of a 60,000 volt circuit passes to a connecting switch by which it is joined to a short, separate bus-bar, and this short bus-bar may be joined by other connecting switches either to another oil switch and then to the regular 60,000 volt bus-bars, or else to another oil switch and then to the primary coils of its transformer. By this combination of switches with the short and the regular 60,000 volt bus-bars, each conductor of a three phase transmission circuit may be connected, through two oil switches in series, with the primary coils of its usual group of transformers, or through a series of two oil switches with the regular 60,000 volt bus-bars. Any group of three transformers may have its primary coils connected to the regular 60,000 volt bus-bars, through a series of two oil switches and one of the short bus-bars. The result is that any conductor of a 60,000 volt transmission circuit may be connected to either of the four groups of transformers, or all the circuits and transformers may operate in parallel.

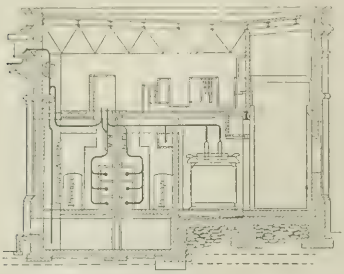


Fig. 5 Sectional View Toronto Terminal Station.

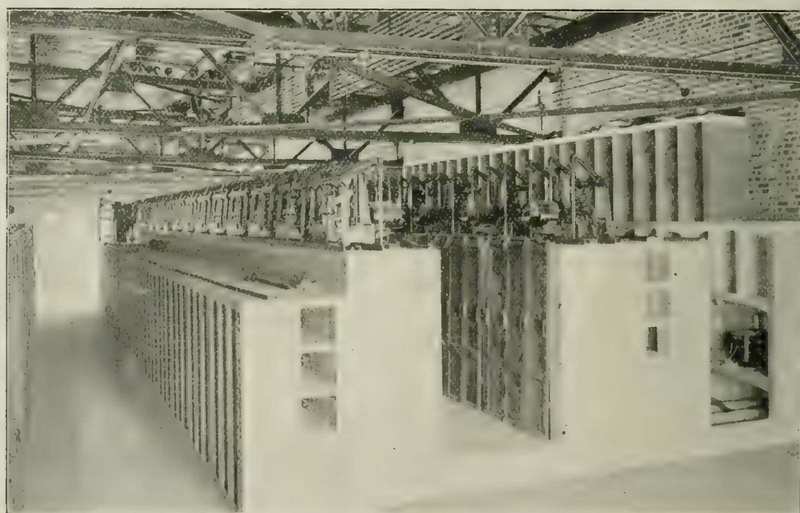


Fig. 6 Oil Switches and Bus-Bars, Toronto-Niagara Terminal Station.

Each of the 2,400-k.w., 60,000 to 12,000-volt transformers is oil-insulated and water-cooled, and is located in a separate pocket, of which the walls are brick and the door steel (Fig. 12). The fifteen pockets for as many transformers are arranged on the same level in a single row and a track for the transformers runs into each pocket. Water pipes from these transformers run to inlet and discharge points and the pipes carrying oil connect with a system of storage and emergency tanks, filters and an air compressor and exhauster. All of the oil piping is of brass.

The 12,000-volt leads from the transformers go to either of two sets of three-phase bus-bars, by way of either of two sets of oil switches. Similar oil switches connect with the 12,000-volt bus-bars the underground cables that run to the several sub-stations about Toronto. There are 31 of these 12,000 volt, motor-operat-

ed oil switches for three-phase circuits, 25 of which are rated at 300 amp. and the remaining six at 500 amp. Each 12,000 volt oil switch is located in three brick and stone cells, similar to those above described. The break or throw of each contact rod in the oil cylinders is 20 in.

Both the 12,000 volt and the 60,000 volt bus-bars

Fig. 7—60,000 Volt Oil Switches.

are carried in cells of brick and stone and in the case of the 12,000 volt bus-bars, their cells adjoin those of the corresponding oil switches. The 60,000 volt bus-bars are located some feet distant from their switches, however, and between the rows of cells that contain the two sets of these bus-bars there is a 13½ in. brick wall.

All of the oil switches are controlled from operating

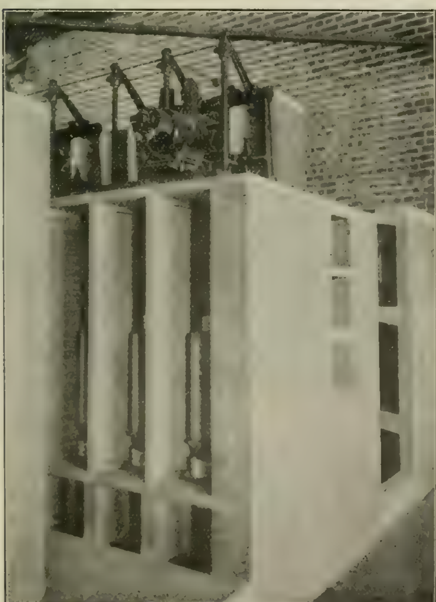


Fig. 8 12,000 Volt Oil Switches.

boards located some distance away, but on the same floor. There are two of these operating boards, one controlling the 60,000 volt, and the other the 12,000 volt circuits. Leads from these controlling boards to the motors that operate the oil switches are run through iron conduit pipes laid in the floor. Besides the controlling switches and dummy bus-bars, the switchboards carry switch operating relays, power factor indicators, and wattmeters and watt-hour meters. A motor generator in connection with a storage battery supplies current at 125 volts, for the operation of the motors of the oil switches, and for lighting the sub-station. For the operation of other motors about the sub-station, a bank of three 15 k.w. transformers step down the 12,000 volt, three-phase, 60 cycle current to 110-220 volts. If the above motor-generator fails to operate, the battery is automatically connected to the lighting circuits.

On the west side of the station, at an elevation of about 42 ft. above the ground, there are four entrance hoods for the four 60,000-volt, three-phase circuits from Niagara Falls. Each of these entrance hoods has three compartments, one for each conductor of its circuit, and is built up of concrete on a steel frame. A terminal tower carrying one three-phase circuit sets close to each entrance hood, and before entering the underside of the hood each conductor is attached to a steel bracket that runs out from the station wall. In the interior of the terminal station, on its east side, a

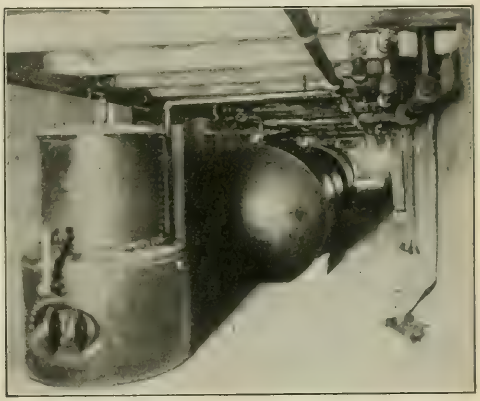


Fig. 9 Oil Tanks in Basement.

clear space about 12 feet ft. wide, and extending from the first floor to the roof, runs its entire length in front of the row of fifteen transformer pockets. Over this area moves a traveling crane for handling the transformers, and a brick wall separates the upper part of the space from the remainder of the second storey of the station. Over this area in front of the transformer pockets the nearly flat tile roof is supported by I-beams, and the remainder of the roof is carried on steel trusses.

In addition to the two-storey space in front of the transformer pockets, the first floor is taken up by these pockets, the busbar compartments and the lightning arrester passages, and the second-storey contains the oil switches and the controlling boards, and also the upper parts of these same passages. On passing through the west wall of the sub-station, each conductor of a 60,000 volt circuit enters a vertical passage, enclosed by brick partitions, that lead to the basement. In the upper part of each of these passages are the connecting switches that lead respeetively to the lightning arresters and to an oil switch. Just beneath these connecting switches is the current transformer, and then comes the long bank of lightning arresters.

After the 60,000-volt conductor passes below the

level of the second floor, it turns into a horizontal passage and runs to a point directly beneath its oil switch. Between the first and second floor the space under the 60,000-volt oil switches is shut in by brick partitions, and is sub-divided by other partitions into separate passages for each conductor. Within this same space are the brick and stone compartments for one set of 60,000-volt, three-phase bus-bars, to which

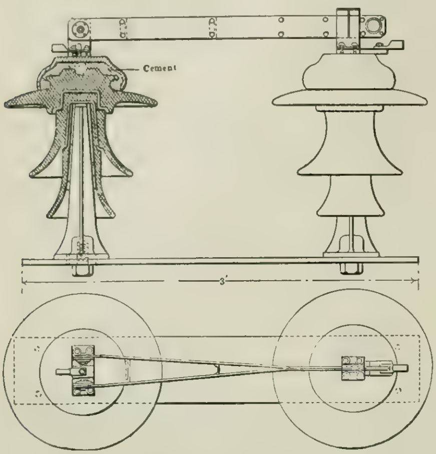


FIG. 10—DISCONNECTING SWITCH.

the conductors from the oil swithes lead. These bus-bar compartments are built against a 13½-in. brick wall, and on the other side of this wall there is another set of 60,000 volt bus-bars and another space running from the first to the second floor, like that just described. On either side of the 13½-in. brick wall between these two vertical spaces there are connecting switches for each conductor.

On the second floor the oil switches are in three rows. Two of these rows are made up of the 12,000 volt switches with the 12,000 volt bus-bars in the same masonry structures, and the third row contains

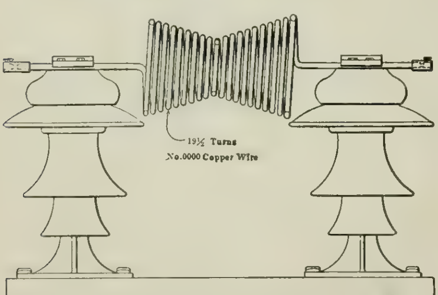


FIG. 11—CHOKE COIL FOR LIGHTNING ARRESTER.

the 60,000 volt switches alone. Across and at one end of the second floor and in view of the oil switches are the control switchboards.

The basement extends under only about one-half of the sub-station, and this half is divided into two parts by a brick wall parallel with the row of transformer pockets. In that part of the basement that is nearer to the transformers are located their oil and water pipes, and also the oil tanks (Fig. 9.) The other part of the basement contains the lower ends of the lightning arresters for the 60,000 volt circuits, and into this part of the basement come the 12,000 volt underground cables that connect the terminal sub-station with the several lighting and railway sub-stations in Toronto.

The terminal station has been erected and equipped under the direction of Mr. Robert C. Brown, chief electrical engineer for the Toronto and Niagara Power Company, from plans by Dr. F. S. Pearson, consulting engineer, New York, while the electrical equipment was manufactured by the Canadian General Electric Company.

LEGAL.

A decision was handed down by Judge Seaman in the United States Circuit Court of Milwaukee, Wis., a few days ago, the effects of which are of the utmost importance to the entire electrical industry. The case involved a suit of the General Electric Company against the National Electric Company in which the former charged that a patent controlling certain features of construction in an electric generator was infringed. This feature refers to a form of ventilating the armature which prevents an overheating of the machine, that is essential to its successful operation and adds about thirty per cent. to its given capacity. This form of ventilation is now in general use by manufacturers. The decision of Judge Seaman, which is of

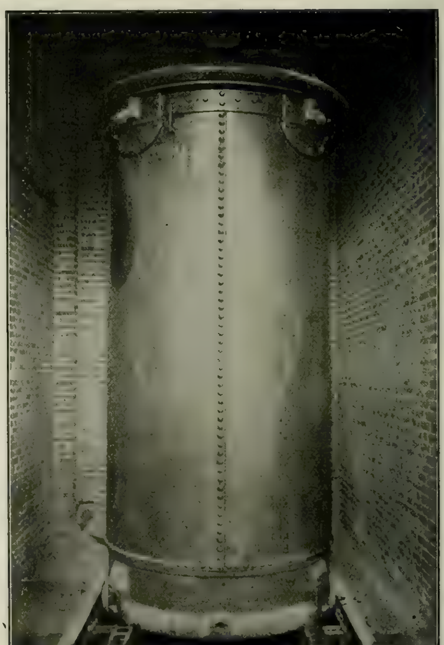


FIG. 12—TRANSFORMER IN POCKET.

greater importance because it is a concurrence of a similar opinion of Judge Thompson of the Ohio District Court, restrains the National Electric Company from the further manufacture of this ventilating feature, and as all other forms now known to the electric business come within the claims of this patent of the General Electric Company, its importance may be appreciated.

The Winnipeg Electric Railway Company, who are engaged in the work of elecirifying their Selkirk and Lake Winnipeg branch, now have cars running as far as Kildonan.

The Canadian Westinghouse Company have just completed a large order for the Vancouver Power Company, consisting of a 3,000 h.p. revolving field generator for direct connection with water wheels, a rotary converter of 1,350 h.p., eight air-blast transformers and the necessary switchboards. This is the fourth Westinghouse generator installed by the Vancouver Power Company.

The Development of the Ontario Power Company*

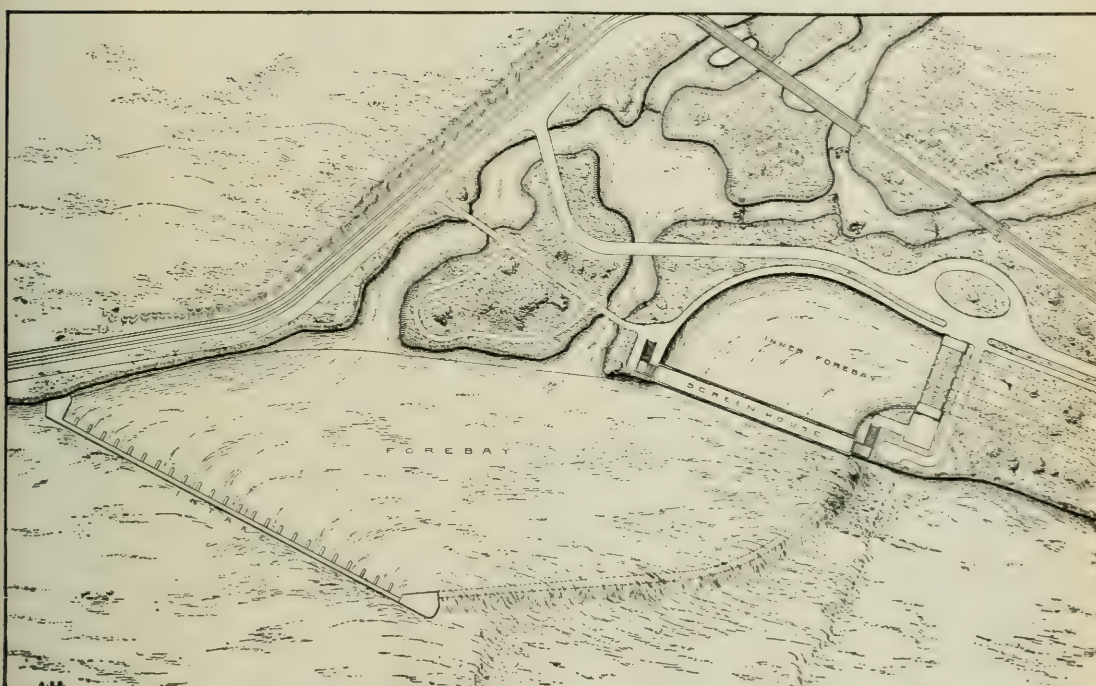
The generating station of the Ontario Power Company at Niargara Falls is situated at the foot of the cliff forming the right hand wall of the gorge. To the right, high above and behind the power house, upon a bluff overlooking both gorge and cataract, stands the distributing station, while away to the left, around the bend of the river and hidden by the trees of Goat Island, are the walls, abutments and buildings of the intake and headgates through which the water from the Niagara river is diverted for use below.

From the head-gates of the company three great steel and concrete tunnels or conduits beneath the surface of the park, convey nearly 12,000 cubic feet of water per second to the top of the cliff above the power house. Thence it passes through 22 steel penstocks in shafts and tunnels down and out though the cliff to an equal numder of horizontal turbines in the power-house below. From the generators the electrical cables turn back through tunnels to the 22 banks of switches, transformers and instruments of the distributing station above and to the transmission lines beyond, completing an equipment for more than 200,000 H.P

The intake works have been located and designed with especial reference to the ice difficulties which have been the limiting factor in the success of Niagara power. Cake ice in enormous quantities floats down weeks at a time from the Great Lakes, and mush ice is formed in the turbulent rapids primarily by the freezing of spray and foam and secondarily by the disintegration of cake ice. To avoid the latter the intake is located in the smooth but swift water just above the rapids; to exclude the former the following features have been introduced: A long and tapering forebay protected at its entrance by the main intake terminates at its narrow, down-stream end in a deep spillway. Upon the river side it is enclosed by a submerged wall, while the other side adjacent to the spillway is occupied by the main screen structure leading to the inner bay and to the portals and head-gates of the three conduits.

The intake, nearly 600 feet long, stretches across the inlet or bay at Dufferin Island almost parallel with the current in the river. Throughout its length a concrete curtain-wall extends down 9 feet into the water, here 15 feet deep, so that the gate openings beneath admit only deep water, and this at right angles to the swift exterior surface flow which, sweeping the full length of the curtain, carries the floating ice to the rapids beyond. At the main screen this operation is repeated. This structure, 320 feet long in 20 feet of water, lies across the entrance to the inner bay and parallel with the direction of flow in the outer bay. Again a curtain, formed by the front wall of the enclosing superstructure, admits to the screens only deep water, here also at right angles, while it excludes ice with the surface currents maintained through the forebay by a voluminous spill of surplus water.

At the gate structure, where the water is 30 feet in



Plan of Ontario Power Company's Intake Works.

*Abstracted, by permission, from a paper read before the American Institute of Electrical Engineers by Mr. P. N. Nunn, Chief Engineer of L. L. & P. N. Nunn, Engineers of the Ontario Power Company.

depth, the tapering portals leading to the electrically operated Stoney head-gates are protected with wide-mesh screens, which are also enclosed and safeguarded by a curtain carried by the front wall of the gate-house. The bay in front of the curtain communicates with the

ONTARIO POWER COMPANY—EXTERIOR VIEW OF GATE HOUSE.

river by an ample ice-run. Substantial concrete build ings shelter both head-gates and main screen. In each case an open canal between curtain and screen spills into a gravity ice-run emptying into the river. Both buildings are supplied with steam for heating and thawing from a underground boiler-plant situated in the common abutment.

Thus the water before entering the conduits must pass in succession three automatically selective steps, each excluding surface water and its floating ice, and two screens, each behind ice-runs in heated buildings containing live steam for emergencies.

The main conduits are of 0.5-in. riveted and reinforced steel imbedded in concrete, 18 and 20 ft. in diameter, 6,500-ft. long, and are buried within the rock and soil of the public park. Through them the water flows at a velocity of approximately 15 ft. per second. Just beneath the top of the cliff behind the powerhouse, within a long underground chamber, the arched roof of which supports the conduit above, 9-ft. diameter branches pass from the under side of the conduit through gate-

ONTARIO POWER COMPANY—BIRD'S EYE VIEW SHOWING GENERATING AND DISTRIBUTING STATIONS COMPLETE FOR 200,000 H. P.

valves and become the penstocks, each supplying water at 10 ft. per sec. to a single turbine. Each penstock has two expansion joints, a massive thrust anchorage in the power house foundations, and an automatic relief-valve and a stone-catch discharging into the river. The 9 ft. valves are electrically operated under distant control from the power house below. The spillway at the end of the conduit, to prevent water hammer in case of sudden loss of load, is little more than the enlarged and elevated end of the main conduit equipped with an enclosed weir and underground discharge.

The generators are of conventional horizontal-shaft type, three-phase, 25 cycle, and deliverd 12,000 volts at 187.5 rev. per min. The turbines are of Francis or inward-flow type, double, central-discharge or balanced twin turbines designed to deliver 12,000 h.p. under 175 ft. head. Their shafts are 24 in. maximum diameter and each carries two 78 in. cast-steel runners of "normal" reaction. Housings are of reinforced steel plate, 16 ft. in diameter, spiral in elevation and rectangular in plan. Gates are of the wicket or paddle type, and the rotating guides forming them are carried by shafts which project through stuffing boxes to an external controlling mechanism, thus freeing the casings from the objectionable interior gate-rigging and leaving their approaches to the guides symmetrical and open. While the velocities in housings and draft-tubes are high, corresponding losses are avoided by nicely modulated changes of both velocity and direction and by symmetrical and liberal curves free from abrupt angles or obstructing projections.

Of the 175 ft. head, 20 ft. is in the 10 ft. diameter draft-tubes, because the floor of the power-house has been elevated 26 ft. above mean water level to provide for the excessive variations to which the water in the gorge is subject.

Although entirely feasible to use the vertical-shaft turbine and although restricted space at the power-house requires greatest floor economy, nevertheless horizontal units are employed on account of their freedom from step-bearings, their higher efficiency, and their greater accessibility.

To reduce load upon the step-bearing, the vertical unit is usually of highest permissible speed. While efficiency at the generator is favored by this high speed, the effect upon the turbine is diametrically opposite and usually many times greater. This is because highest efficiency and durability seem to require "normal" reaction—a radial relative direction of bucket entry—and narrowly limited relative dimensions of runner. At such reaction peripheral velocity of runner (the components of which—diameter and rotation—are inversely proportional) is fixed by head. At such relative dimensions power is proportional to square of diameter; hence, inversely proportional to square of rotation. Increase of rotation, therefore, means disproportionately great decrease of power or abandonment of ideal reaction and relative dimensions. When carried to the extremes usual with vertical units, it results in inefficiently high reaction and reduced area of discharge, unfavorably abrupt changes of direction in buckets, and a wastefully distorted and overworked wheel. To such an extent is this distortion carried to meet especial conditions that it is rare to find a high-head turbine possessing nearly the efficiency or durability possible if correctly proportioned. In the present case the speed selected permits almost exact "normal" reaction and ideal proportions without sacrifice at the generator.

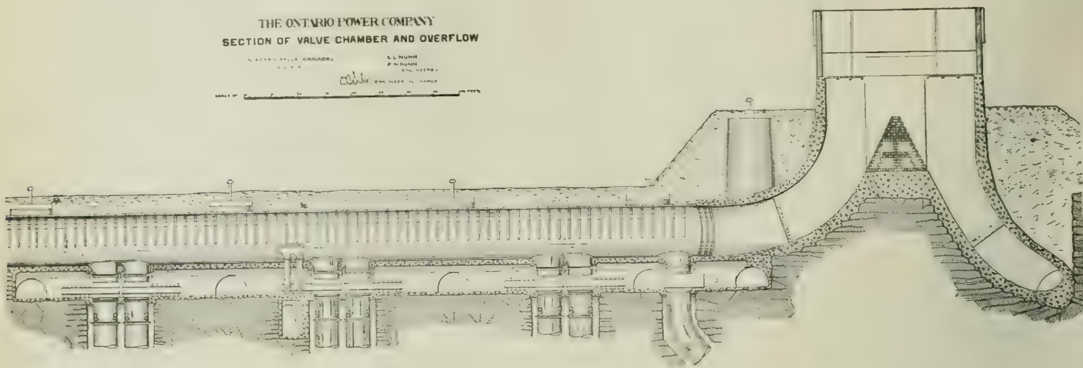
ONTARIO POWER COMPANY—SECTION THROUGH GENERATING AND DISTRIBUTING STATION.

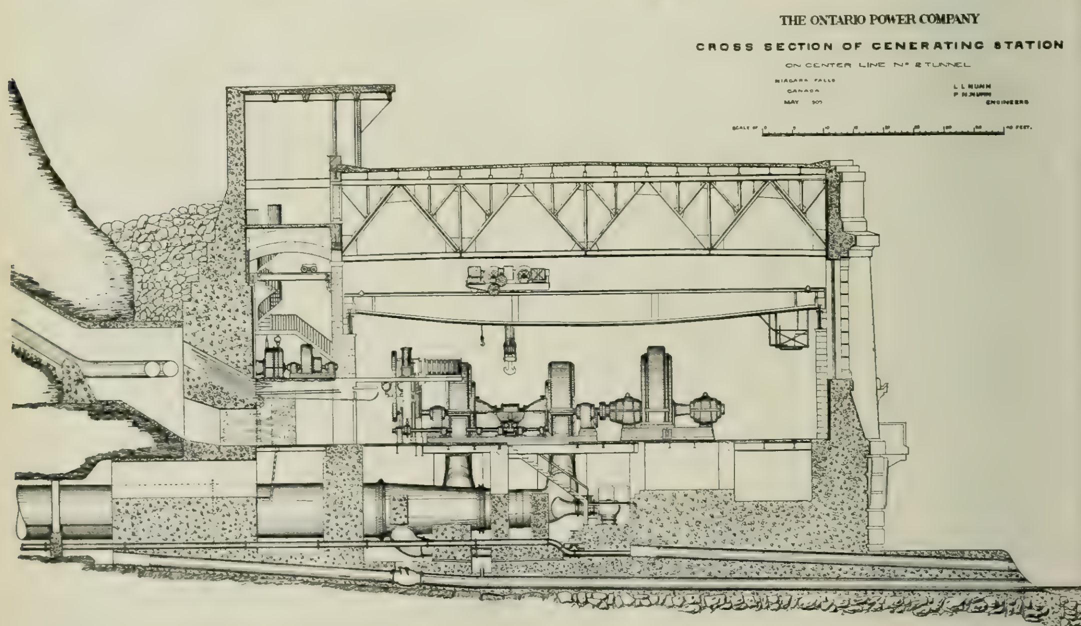
In the general arrangement of the works, symmetry and centralization of control are predominant characteristics. The generating and distributing stations are parallel and 600 ft. apart with 260 ft. difference in elevation. On account of limited space the generating station is but 76 ft. wide, though when completed it will be nearly 1,000 ft. long. Down the center of this building side by side in a single row, stand the generating units with turbines next their source of supply. The space between them and the rear wall is occupied by a gallery upon which stands the row of oil-pressure governors, each almost over the end bearing of its turbine.

The distributing station, wider and shorter than the power-house, is divided into three longitudinal bays or

five main sections. The narrow front bay contains the switches, bus-bars, etc., at generator pressure; the wider rear bay contains those at transmission pressure. Between these stretches the main middle bay divided transversely by a three-floor switch-board-section into two long transformer rooms. The projecting central section provides space for the operating offices. Along the center of these two rooms the transformers stand in groups of three corresponding in position and capacity to their respective generators. Thus similar accidents. On the contrary they are laid quite regardless of switchboard, the switches and instrument transformers of which are then placed as required by the cables.

Unit values, corresponding to the generators in capacity and position, are maintained throughout. Thus each generating unit has its individual cables, switches and switchboard, section of bus-bars, transformers, interrupters, and high-pressure switches complete to the transmission, enabling independent





appartus is arranged in rows parallel one with another and with the generating units.

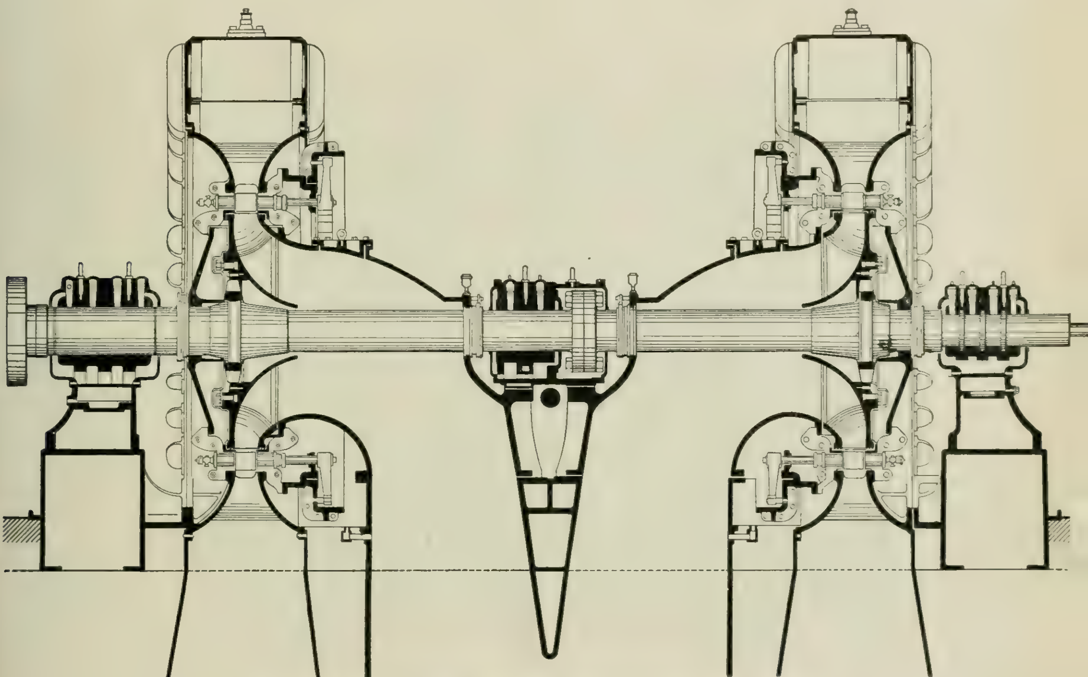
At the generating station three inclined cable-tunnels, carrying clay ducts, begin at the rear wall beneath the gallery and extend up through the cliff and, as standard subway, on to the distributing station. The main cables, except as diverted by these tunnels, follow the shortest and most direct routes from generators to transformers. They do not converge for the acommodation of switchboard at one or more centers where congestion prevents separation or adequate insulation, and in many installations causes the most disastrous operation as an isolated power-plant or, through the selector switches and duplicate sectional bus-bars, the operation of all units in any combination of groups as readily and perfectly as their operation in parallel. To this end a unit length of distributing station of similar relative position is devoted to the circuit and apparatus corresponding to each generator.

From the above it may be seen that the arrangement is in parallel courses; that like apparatus is arranged in rows of courses parallel with the long axis of the generating and distributing stations; that the main circuits and the unlike apparatus performing the

successive functions of these circuits from 22 courses transverse to the same, and that the courses of the two directions form, as it were, a rectangular or checker-board figure covering an area nearly 1,000 ft. square. The arrangement of these courses in logical sequence provides the short and direct route for the main cables previously mentioned.

Where the cable tunnels commence, the power-house and gallery are widened toward the cliff. Immediately above the tunnel entrance are the main generator switches, and on one side the duplicate turbine-driven exciters and their governors, and on the other the motor-actuated main field rheostats. In front of the switches are a few panels of switchboard carrying exciter rheostats and switches, controls for actuating penstock valves, and the necessary circuits and apparatus for a limited local distribution. Relief valves interrupters or other protective apparatus. Beneath both and between their foundations are accommodated the several systems of piping for water, oil and drainage and the main cable-ways to the transformers above. Each transformer is fitted with a record-making thermometer giving the continuous history of internal economy.

The switchboard section occupying the center of the distributing station has four floors of which the basement serves as a center for the piping systems and gives room for conduits and cableways for wiring. On the main and the mezzanine or gallery floors are marble slabs carrying record-making and integrating instruments, terminal boards with fuses for the control cables, and other adjuncts of the switchboard above. Upon the upper floor is the switchboard and control chamber, and here instrument-stands and control-



Ontario Power Company—Sectional Detail of Horizontal Turbine.

and small drainage-pumps are the only operating machinery beneath the main floor, while upon it, in addition to the generating units, there are only duplicate electrically driven pumps supplying the storage tanks and transformer cooling coils at the distributing station. For air circulation and ventilation and to avoid dampness from spray as well as to insure cool generators in hot weather, a cold air supply to each generator is provided from a sub-floor chamber communicating with external shafts and heated air escapes through large roof ventilators.

At the distributing station the low-pressure bay contains upon the main floor the 12,000 volt automatic oil circuit-breakers in double column and, in the chamber beneath, only the sectional duplicate bus-bars and their immediate connections. In the transformer rooms the transformers stand in pits six feet below main floor level, and parallel with them adjacent to the high-pressure bay are corresponding pits for static pedestals supplant both the conventional marble slabs and the later bench-board. Each of the 22 instrument-stands, which are arranged approximately in a semicircle about a central point, corresponds to a definite unit, carries nine indicating instruments and faces its twelve-point control pedestal.

Centralization of responsibility and authority, at defined points within the immeniate personal care of a minimum number of chief operators, is,next to simplicity of arrangement, the prime requisite of efficiency of organization and of economy of operation. It is frequently possible so to arrange small plants of a few units as to centralize at a single operator, but with a plant of this scope that result is manifestly impossible. Two alternatives are then open: the division of the plant into several parts, each about its subcenter constituting a complete plant in itself and the whole dependent upon successful cooperation for unity of results; or classification and centralization of responsi-

bility according to kind. In this case the latter has been adopted, and notwithstanding that the number of units and aggregate of power involved have opposed high merit in this respect, a promising result has been obtained.

The concentration within a single room of all instruments and control—the brain of electrical operation—provides the operator in a quiet and secluded place both full information and perfect control of every electrical circuit and situation of the system and enables him to stop, start, regulate or synchronize each unit; to throw its output through its transformers to its transmission as if from a complete isolated plant or to throw it upon either bus-bar while supplying its transformers from the same or other bus-bar. The location of this room high up at the geometrical center of the distributing station places the operator at a point of vantage surrounded by four classes of apparatus. Thus located he may with few steps survey his entire field; look down upon switches, bus-bars and arresters of the high-tension; see at a glance every low-pressure switch; or watch trouble in either transformer-room.

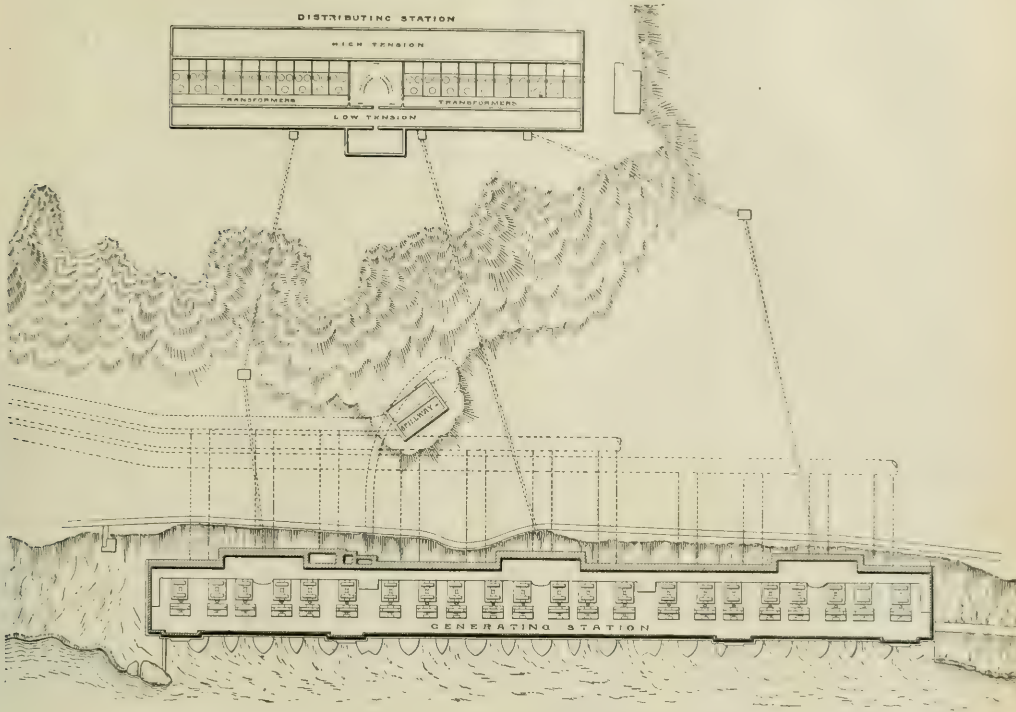
At the generating station the corresponding vantage-point is the gallery, where on one side the operator has the motor-driven rheostats and a few paces distant the commutators and governors of the exciters, and on the other side in plain sight the row of main governors with their adjuncts; while from the little switchboard before him he has electrical control of penstock gates and, when necessary, manual control of turbine speeds, exciter pressure and field charge. Moreover, from this position he can see all generators and turbines, and, by signal at least, can direct his assistants; little, in fact, is likely to call him to the main floor unless it be an occasional refractory journal or collector brush.

In accomplishing the centralization of switchboard simultaneously with the broad and symmetrical distribution of main circuits and switches already described, distant electrical measurement and control have necessarily been employed to an unusual extent. Pressure and current transformers, essential to the many instruments and relays beyond those necessary at generating station and high-pressure room, are mounted in the bus-bar chamber. The innumerable and long conductors, necessary to extend over the intervening distance from those to the many instruments of the switchboard and to convey back the power from relays and control buttons to automatic switches, have been gathered into substantial cables and laid in metal conduit.

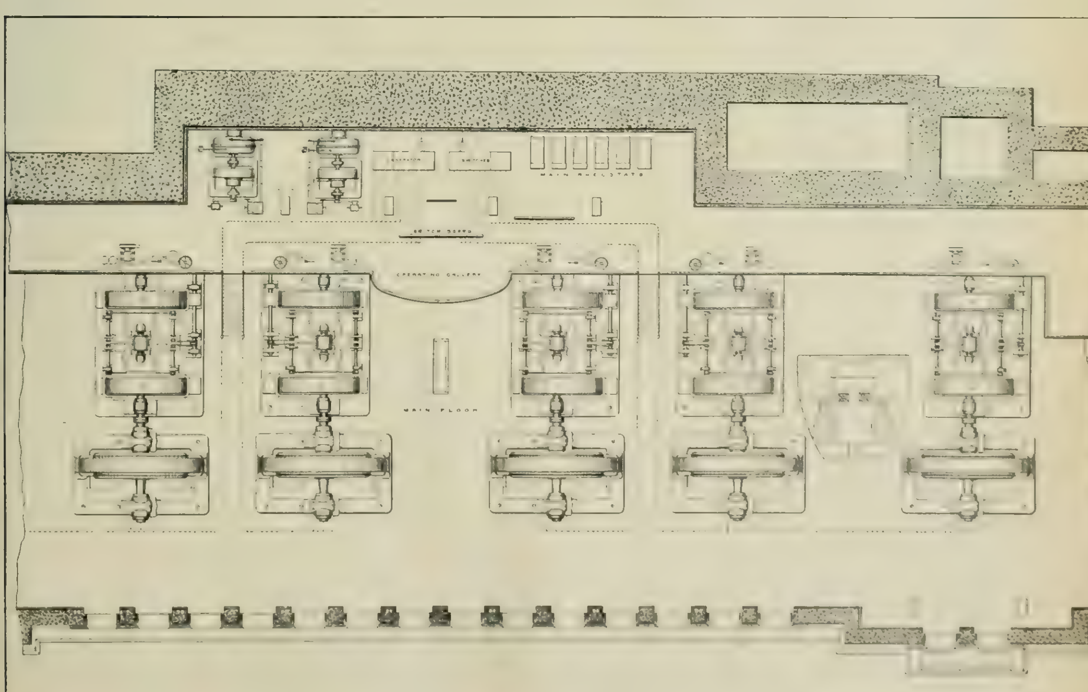
The basement of the central bay along its low-pressure side forms a wiring chamber supporting a railway track upon the main floor above. Through this wiring chamber transverse to the general direction of the main cables and opening at its center into the control section, these cables and those for both continuous and alternating current local service are carried into the basement beneath the control section and, rising through the recording floors, end at terminal boards below their respective instruments and relays. Carried thus far, distant control has been still further applied by the use of motor-driven rheostats for both generators and exciters, electrically operated circuit-breakers for field circuits, and speed controllers for governors whereby, as previously mentioned, turbines may be started, stopped or regulated from the control chamber as well as from the gallery at the generating station.

Ontario Power Company—Eighteen Foot Diameter Conduit Showing Concrete Envelope.

The isolation of electrical apparatus and conductors by incombustible walls or barriers against spread of oil or arcs, for protection from fire and from each other, is of importance proportional to the power and investment involved. Some rather extreme measures here taken for its more complete application may be of interest. The five sections or rooms, heretofore mentioned, forming the distributing station, are of concrete-and-steel fireproof construction, separated by full-



ONTARIO POWER COMPANY—PLAN OF ELECTRICAL WORKS.



ONTARIO POWER COMPANY—PLAN OF GENERATING STATION, UNITS 2 TO 6.

height masonry walls with intervening air-spaces. No windows and but few doorways (these latter protected by fireproof doors usually closed) penetrate these walls.

The transformer pits already mentioned, each containing a bank of three transformers, are isolated and extended to a height of 23 ft. by masonry fire-walls. Each individual transformer is in a boiler-iron casing designed to withstand 150 lb. per sq. in. explosive pressure. Each case communicates through an 8 in. pipe from its top with a special drain for free vent in case of accident.

The power from each generator is conducted to its switch through three single-conductor braided cables carried by line insulators and isolated by shelf barriers in a subway beneath the floor. From the switches the three conductors pass to a bell chamber where between individual barriers they are united into two parallel three-conductor lead-covered and armored cables before entering the tile ducts of the cable tunnel. Around the few bends at manholes each cable remains always within its compartment, between horizontal or vertical barriers as required. At each point where a circuit enters the distributing station, a manhole maintaining the same segregation and communicating with the bus-bar chamber is provided for the change from three-conductor to single-conductor cable. After entering the building the cables pass between vertical barriers as before beneath and through the floor to the switches above.

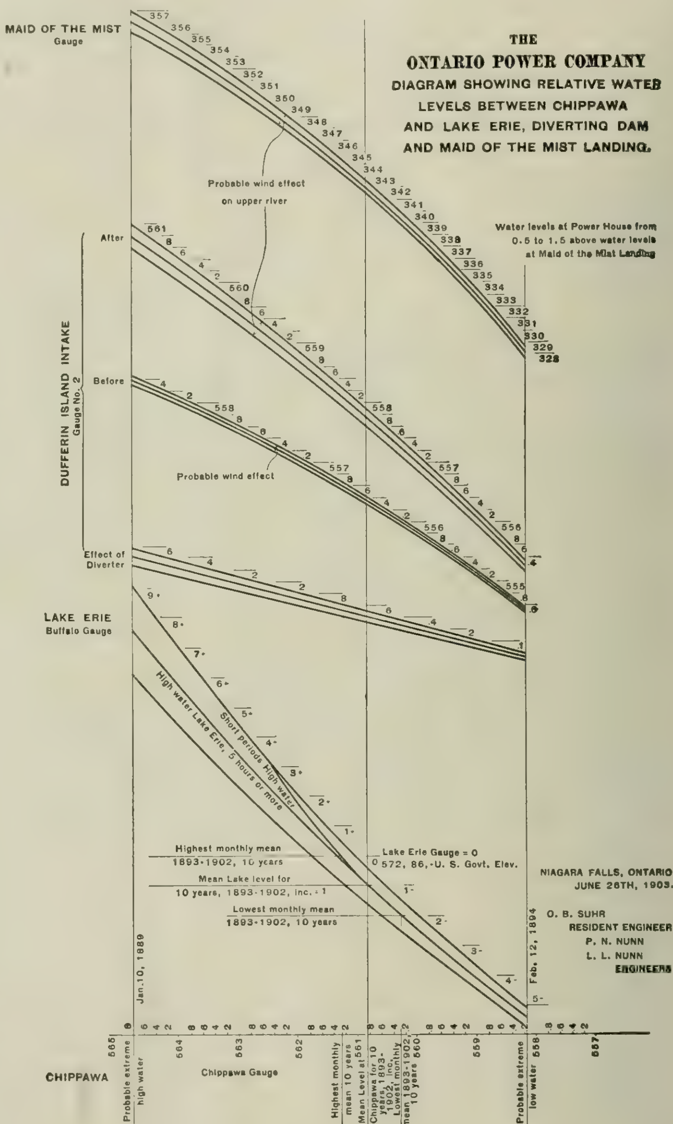
Bus-bar structures are composed entirely of concrete with mortised reinforced-concrete shelf-barriers between bus-bars. Connecting leads pass through the wall forming the center of the structure, and thence in compartments formed by vertical barriers of the same material, directly up to the switches above. Instrument transformers are also installed within similar individual compartments and these whole structures like those of the switches are closed by fireproof doors. Control cables are laid in metal conduit throughout their courses except in the wiring chamber beneath the track, where they are arranged upon metal shelf-pans filled with dry sand, into which connecting conduits dip.

Mr. O. B. Suhr has from the beginning been in charge of the engineer corps, and to him is largely due the harmony of design. Mr. V. G. Converse, Mr. C. H. Mitchell and Mr. J. B. Bailey are chiefs of the electrical, mechanical and field departments respectively and Mr. J. R. Harsch of the clerical work of the engineers.

ONTARIO ASSOCIATION OF STATIONARY ENGINEERS.

The fifteenth annual meeting of the Ontario Association of Stationary Engineers was held in Hamilton last month. W. L. Outhwaite and A. E. Edkins, of Toronto, were appointed auditors for the ensuing year, and the committee appointed on the good of the order consisted of O. P. St. John, W. L. Outhwaite, A. E. Edkins, Toronto; W. Stewart, Hamilton, and E. Phelps, Sarnia. The Committee on Legislation reported most favorably on the bill which recently passed the House regarding the licensing of stationary engineers. This was adopted and a hearty vote of thanks tendered to the members of the committee for the valuable services rendered to the association.

The following officers were elected: A. M. Wickens, president; W. Sweet, vice-president; W. G. Blackgrove, Toronto, registrar; C. Moseley, Toronto, treasurer.



TRANSMISSION LINES FOR NIAGARA POWER

The line constructed by the Toronto & Niagara Power Company for the purpose of transmitting to Toronto the electric energy generated by the Electrical Development Company is 75½ miles in length and is carried on steel towers along each side of the right-foot right of way, spaced 400 feet apart. The towers are constructed of galvanized steel angles bolted together with bracing similar to the usual design of windmill towers. Most of the towers are 46 feet high, with a base 14 feet x 12 feet. Lengthwise of the line each tower has a uniform width of 14 feet from bottom to top, but crosswise the width of 12 feet at the bottom diminishes, the sides coming together at the top. A steel pipe forms a cross-bar, carrying four steel pins, on which insulators are placed. The other insulators are placed on vertical steel pipes, so that the conductors of each circuit form an equilateral triangle, with a horizontal base of 6 feet. The towers are designed to withstand a side strain of 10,000 pounds applied to the top.

Where unusual conditions exist, special towers have been provided. The accompanying illustration shows the towers crossing the Michigan Central Railway near Niagara Falls. About seven miles from Niagara Falls the line crosses the Welland canal on towers that carry the conductors 150 feet above the water, and on these high towers lightning rods are used. For about six miles the line carries a galvanized steel cable above the copper conductors as a lightning guard wire. On the north shore of Lake Ontario, near Bronte, the line crosses the gorge of Twelve Mile Creek with a span of 630 feet long. At 63 miles from the Niagara terminal station is the crossing of the Credit river, where the span between towers is 766 feet.

The Toronto-Niagara Transmission Line, Showing Angle Towers Crossing Michigan Central Railway near Terminal Station at Niagara Falls.

Each line of towers will carry two groups of three copper conductors, forming a three-phase circuit, which is designed to receive current as 60,000 volts from Niagara Falls and to deliver 12,000 horse power in Toronto with a loss of less than ten per cent. in voltage. The conductors are composed of six strands of No. 6 copper wire wound about a hemp core. The combined area of the strands is 190,000 circular mils.

The insulators are glazed brown porcelain, about 14 inches in diameter of top umbrella and about 14 inches high over all.

The transposition of the conductors is carried out in an interesting way. The transposition tower has two cross arms instead of one like the standard towers and carries two wires of each circuit above the third. From the fiftieth to the sixtieth mile, approximately, of the transmission line, the transposition of the conductors is more frequent than elsewhere, and there are four complete spirals in that section. Three division houses are so located along the line as to cut it into four nearly equal sections. Each conductor in a division house is connected with a lightning arrester made for 60,000 volts by the Canadian General Electric Company. This lightning arrester contains 240 air gaps between brass cylinders and 60 carborundum rods, all in series from the line cable to the earth. A complete lightning arrester is mounted on porcelain lined insulators and is 25½ inches wide and 19 feet long.

The towers for the Toronto-Niagara transmission line were built by the Canada Foundry Company, of Toronto.

NIAGARA-SYRACUSE TRANSMISSION LINE.

A transmission line modelled somewhat after that of the Toronto-Niagara Power Company is now under construction to transmit electric current from the power house of the Ontario Power Company on the Canadian side of Niagara Falls to Syracuse, N. Y. The length of this line will be 160 miles. The western half of the line will be carried upon steel towers spaced 550 feet apart. These will differ from the usual wind-mill type in having three legs instead of four. Each tower will carry a top insulator and a single cross arm with the other two insulators, and the whole tower system is to be in duplicate, each tower line carrying a single circuit. From Rochester to Syracuse A-shaped towers of wood will be used, spaced 220 feet apart. There will be about 1,500 steel towers and 2,500 wooden towers. The voltage, as with the Toronto-Niagara line, will be 60,000, which is considered about the limit at present. The insulators will be the largest used in a Niagara transmission. They weigh about 75 pounds each and have two petticoats and a hood, the latter having a diameter of about 14 inches.

The Niagara Falls Electrical Transmission Company has recently been organized, with a capital of $5,000,000. This company, of which Mr. Frederic Nicholls, of Toronto, is president, will act as the distributing agents in New York state for power developed by the plant of the Electrical Development Company of Ontario, on the Canadian side of the river. It is proposed to cross the Niagara gorge on a new bridge to be built about 300 feet below the present upper steel arch bridge and to be wholly devoted to electric railway and power cable services.

The Canadian Niagara Power Company in conjunction with the Niagara Falls Power Company, transmit about 24,000 electric horse power from Niagara Falls to Buffalo. The former company is about to erect a transmission line along the Canadian side of the river from the Falls to Fort Erie, where the cables will cross high over the river to Buffalo.

THE LARGEST STEEL PENSTOCK IN THE WORLD.

Among the many interesting engineering features connected with the hydraulic development at Niagara Falls, the gigantic steel penstock of the Ontario Power Company on the Canadian side of the river occupies

PENSTOCK WORK AT NIAGARA FALLS—BOLTING PLATE IN POSITION.

an important place. Incidentally, but a fact of considerable interest in itself, this is the largest steel conduit in the world. It is 18 feet in diameter, made of ½" steel plate and about 6,000 feet long. Each course was formed of three plates and all seams, both longitudinal and cross, were double riveted. At intervals of 4 feet throughout the entire length of penstock 8-inch deck beams were riveted on for stiffening purposes.

The tube starts at a point opposite Dufferin Island

PENSTOCK WORK AT NIAGARA FALLS—NO. 1 PIPE FROM END OF LAND WALL AT HEAD BLOCK.

and inscribes an immense arc to a point on the brow of the cliff, some distance below the Horseshoe Falls, where it discharges into small branch penstocks leading to the turbines in the power house, located on the river bank far below.

The penstock was laid through Queen Victoria Park and was built on concrete piers in a trench, which was filled in after work was completed, so that both tube and piers were covered from sight, leaving no indication above the surface of the tremendous volume of water rushing along just beneath.

In erecting this steel tube the contractors, The Jenckes Machine Company, Limited, of Sherbrooke, Que., built a temporary plant at the site, equipping it with most modern tools, and the plates were shipped directly there from the makers in Scotland. Roughly speaking, 8,500,000 lbs. of steel plate, 510,000 lbs. of rivets and 1,110,000 lbs. of deck beams entered into the construction, the whole totalling the stupendous weight of 10,110,000 lbs.

A standard gauge track was laid from the plant along the full length of the pipe line. A special self-operating flat car, equipped with boiler, hoisting engine and derrick, kept pace along the track with the progress of the tube. To this travelling steam derrick the plates were conveyed from the plant on lorries, and by means of the derrick they were lifted into place to be there bolted in readiness for the rivet gangs. All riveting as well as caulking was done with pneumatic tools, the air being furnished by a 1,500 foot Rand duplex air compressor installed in the plant.

Before leaving the plant the plates were carefully cleaned by means of a sand blast both where seams and deck beams would come, then coated with linseed oil. After erection the whole was thoroughly cleaned

PENSTOCK WORK AT NIAGARA FALLS—LAYING DRAINS IN PIPE TRENCH.

by sand blast and given three coats of paint both inside and out.

The contract for this huge penstock was signed in August, 1903, operations were commenced as soon as temporary plant could be completed, continued throughout the winter in the face of no mean obstacles offered by cold and inclement weather, and was successfully completed in the autumn of the following year.

It was far and away the largest contract of the kind ever undertaken by a Canadian company and the fact that the great work was carried through without a

PENSTOCK WORK AT NIAGARA FALLS—INSIDE OF NO. 1 PIPE AT CURVE BELOW FALLS VIEW.

hitch of any consequence reflects no little credit on the contractors.

The Ontario Power Company's concession is for 180,000 h. p. and the tube already in place conveys sufficient water to develop 60,000 h. p., so that for the full concession there would be required three penstocks of similar size to the one already in place. The head works for these two additional penstocks are already in place and the building of the penstocks themselves is a question merely of time.

SUCCESSFUL STUDENTS IN ELECTRICAL ENGINEEIRNG.

The result of the examinations of the School of Practical Science in connection with the University of Toronto were announced just after our May number had gone to press.

DEGREE OF B. A. SC.

The following students of the fourth year in the Faculty of Applied Science have fulfilled all the requirements of the University in Applied Electricity for the degree of B.A.Sc:

Honors—H. S. Fierheller, Toronto ; W. E. Turner, Saskatoon, Sask.

Passed—W. G. Hewson, Niagara Falls, Ont. ; R. W. Moffatt, Bognor, Ont.; J. P. Watson, Acacia, Ont.; G. Kribbs, Hespeler, Ont.

ELECTRICAL AND MECHANICAL ENGINEERING.

The following students in the different years were successful in the Electrical and Mechanical Engineering course:

THIRD YEAR.

Honors—W. L. Amos, Guelph, Ont.; G. C. Armer, Chesley, Ont.; H. H. Betts, London, Ont.; R. E. C. Chadwick, Toronto; George A. Colhoun, Alvinston, Ont.; N. P. F. Death, Dixie, Ont.; A. H. Hull, Hamilton; D. G. McIlwraith, Galt, Ont.; W. Maclachlan, Toronto; W. K. Sanders, St. Thomas, Ont.; C. L. Vickery, Port Perry, Ont.; J. N. Wilson, Shanly, Ont.; E. M. Wood, Sweaburg, Ont.

Passed—F. W. Baldwin, Toronto; F. Barber, Toronto; W. C. Blackwood, Toronto; H. E. Brandon, Toronto; F. M. Byam, Toronto; A. Cameron, Marmora, Ont.; A. W. Campbell, Toronto; C. S. Dundas, Putnam, Ont.; S. L. Fear, Amherstburg, Ont.; J. Gray, Port Credit, Ont.; C. B. Hamilton, Toronto; J. C. Hartney, Toronto; C. R. Hillis, Watford, Ont.; C. W. Holloway, London Ont.; R. H. Hopkins, Lindsay, Ont.; W. C. Jepson, Niagara Falls, Ont.; T. Jones, Brantford, Ont.; A. P. Linton, Galt, Ont.; J. A. McPherson, Bolsover, Ont.; W. A. Maxwell, Windsor, Ont.; L. R. Miller, Orillia, Ont.; D. G. Park, Chatham, Ont.; G. W. Paterson, Belton, Ont.; N. R. Robertson, Walkerton, Ont.

SECOND YEAR.

Honors—F. G. Allen, H. D. Bowman, A. M. Carroll, J. H. Castor, S. D. Evans, F. R. Ewart, H. O. Hill, C. H. Hutton, L. G. Ireland, R. W. Kay, D. F. Keith, D. J. McGugan, A. H. McIntosh, J. B. Minns, H. A. Percy, F. E. Prochnow, G. E. Quance, H. Raine, A. C. Spencer, J. L. Stiver.

Passed—J. E. Anderson, C. C. Bothwell, G. A. Campbell, C. A. Clendenning, C. B. B. Connell, G. P. Coulter, A. Crawford, G. A. Dawson, C. S. Grasett, K. Hall, R. A. Hare, E. W. Hyman, A. D. LePan, J. A. D. McCurdy, F. W. McNeill, F. R. Macdonald, S. A. Marshall, H. V. Maynard, J. D. Murray, J. J. O'Sullivan, J. F. Procunier, A. B. Richardson, C. W. B. Richardson, E. R. Smithrim, G. S. Stewart, C. R. Thompson, A. F. Wilson, M. H. Woods, J. Young.

FIRST YEAR.

Honors—O. F. Adams, L. F. Allan, S. E. Annis, P. H. Buchan, J. H. Coyne, J. Darroch, S. S. Gear, C. L. Gulley, F. L. Haviland, A. N. Hunter, J. T. Johnston, J. N. M. Leslie, F. C. Lewis, G. McLeod, F. H. Moody, A. C. Oxley, C. L. Pearson, C. F. Pudlow, J. T. Ransom, N. H. Reesor, H. A. Ricker, D. Ross, J. W. R. Taylor, V. C. Thomas, B. Waugh, F. D. Wilson, R. Young.

Passed—H. V. Armstrong, H. C. Barber, W. J. Beaven, R. E. Beith, G. G. Bell, A. M. Bitzer, G. E. Black, H. F. Bowes, G. H. Brace, E. I. Brown, C. E. Brown, N. A. Campbell, G. Challen, C. W. Colvin, W. H. Delahaye, R. H. Douglas, J. W. Hackner, R. H. Hall, S. B. Iler, W. C. Killip, H. R. Lynar, J. F. McCracken, J. H. McKnight, J. E. Malone, E. D. Monk, J. H. Morice, J. E. H. Mowbrey, S. Murray, V. J. O'Donnell, W. DeC. O'Grady, J. J. O'Hearn, M. Pivnick, A. J. Proctor, R. C. Robinson, W. E. V. Shaw, J. J. Spence, G. E. Squire, J. D. B. Stalker, R. H. Starr, D. S. Stayner, A. W. J. Stewart, J. St. Lawrence, J. J. Stock, A. D. Sword, C. P. Van Norman, W. J. C. Webster, R. M. Wedlake, R. P. Weir, W. J. White, F. F. Wilson, F. L. Young.


MR. W. E. TURNER, Saskatoon, Sask.


MR. G. KRIBBS, Hespeler, Ont


MR. J. P. WATSON, Acacia, Ont


MR. H. S. FIERHELLER, Toronto.


MR. R. W. MOFFATT, Bognor, Ont.


MR. W. G. HEWSON, Niagara Falls, Ont.

FOURTH YEAR GRADUATES IN APPLIED ELECTRICITY, SCHOOL OF PRACTICAL SCIENCE, TORONTO.

Generating Plant of the Canadian-Niagara Power Company

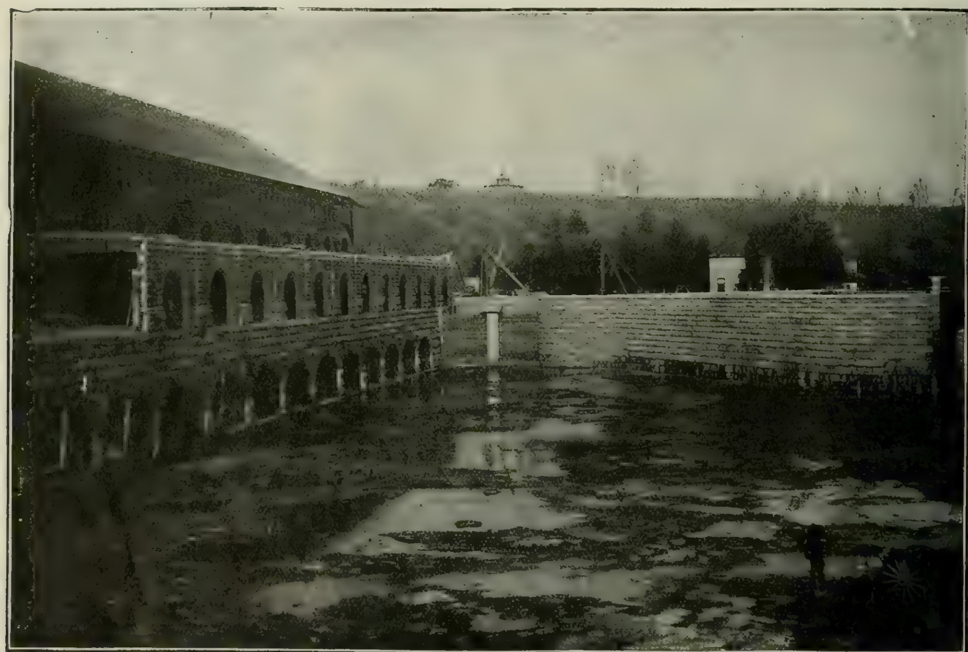
Rights to develop water power on the Canadian side of Niagara Falls to the extent of 100,000 h.p. were granted to the Canadian Niagara Power Company in 1892, but it was some years later before construction work was begun. This company adopted the tunnel and wheel pit method of development and decided on 10,000 h.p. units, whereas its allied company, the Niagara Falls Power Company, were operating 5,000 h.p. units on the American side. The canal has been built for 100,000 h.p., the wheel-pit for 110,000 h.p., and hydraulic and electrical equipment installed to the extent of 50,000 h.p.

Some hazardous and approximate soundings had been taken in the Niagara River at the canal entrance, but they gave assurance that the depth of water adjacent to shore was sufficient without extending operations very far out into the rapids, and a cofferdam was built. A stone and concrete bridge 55 feet wide, composed of five spans of 50 feet each, was constructed across the entrance canal, to carry the tracks of the International Railway Company and to provide for a park drive and a sidewalk. A view of the bridge and outer ice-rack is shown on the opposite page.

The canal walls were carried out to the river entrance by 50 ft. curves, and from the bridge, westward, expand out into a forebay 570 feet long. After deducting all losses the net effective head that this plant is designed to operate under is 136 feet with all wheels running and under this head about 8,870 cubic feet per sec. will be the maximum draft. This amount of water will pass through the bridge openings at about 2¼ feet per second with river at normal level, but in the forebay, under the same condition, the water will approach the line of submerged arches, supporting the forebay room, at only 1 ft. per second.

The Niagara river is, of course, never frozen over at the canal entrance, but after a prevailing east wind the drift ice from Lake Erie and the frazil ice formed in the rapids immediately above the works, come down in a steady flow from 50 to 100 feet wide, hugging the Canadian shore, and prepared to float into the canal whenever a flow of water creates a tendency or draft in that direction.

The ice-rack is supported vertically by first-class masonry piers, 29 feet centres, and consists of a steel footwalk with never-slip plates and another steel beam some 8 feet lower; these carry 2 inch rods spaced 12 inch centres, extending 4½ feet below and 4 feet above meanwater level, and sloping at 30° with the tops down stream.



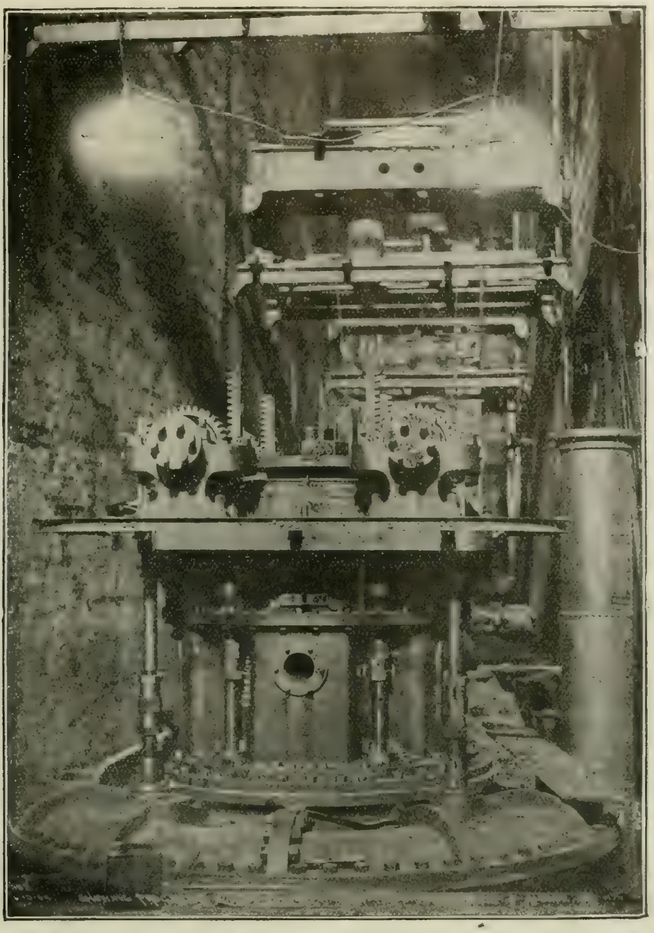
Canadian Niagara Power Company—General View of Power House, Forebay and Canal.

The water, after passing the fine ice rack, enters 18 ft. openings in the masonry inlet walls, thence passes through the cast iron penstock mouth-pieces, which are elliptical (18 ft. x 12 ft.) at the outer.

The wheel pit is 570 feet long and 18 feet wide. The lining consists of 24 inches of solid shale brick from invert up to rack deck, and 12 inches of solid shale brick backed by 4 inches of hollow brick thence to top, is anchored to the rock walls by anchor bolts with wedges and having large plate washers embedded in the brick work.

TAIL-RACE TUNNEL.

The tail-race tunnel is of a section 25 feet high, with a composite lining, the bottom and sides being of



Canadian Niagara Power Company—10,000 H. P. Unit at Balancing Position.

Canadian Niagara Power Company—Bridge and Outer Ice Rock.

concrete, faced with 4 inches of highly burnt brick, while in the arch a brick ring with dry packing was adhered to.

The tunnel is 2,200 feet long, including the headworks at portal, which consists of a square headwall 60 feet wide, 12 feet thick, and 55 feet high, extending to a depth of 35 feet below water level resting on a foundation well into the medina sandstone; from this headwall the tunnel rises in an ogee curve for some 80 feet to the tunnel proper, and this portion is lined with 2 feet of granite, which it was considered advisable to use in place of brick, owing to the excessive speed of the water when dropping to the river level, it being understood that the invert of the tunnel at the top of the ogee curve is at the low water river level.

POWER HOUSE.

The power house is a heavy steel framed building, and when finally completed will be 600 feet long, with main entrance at the north end. The main building is 40 feet high to the eaves, and has crane girders 31 feet above the floor. The exterior walls are of Queenston grey limestone, and the interior lining consists of a wainscotting of enamelled brick up to the window sills, then a belt course of green veined Vermont marble in line with marble window sills. Above this is buff brick. The roof is of steel and terra cotta tile only.

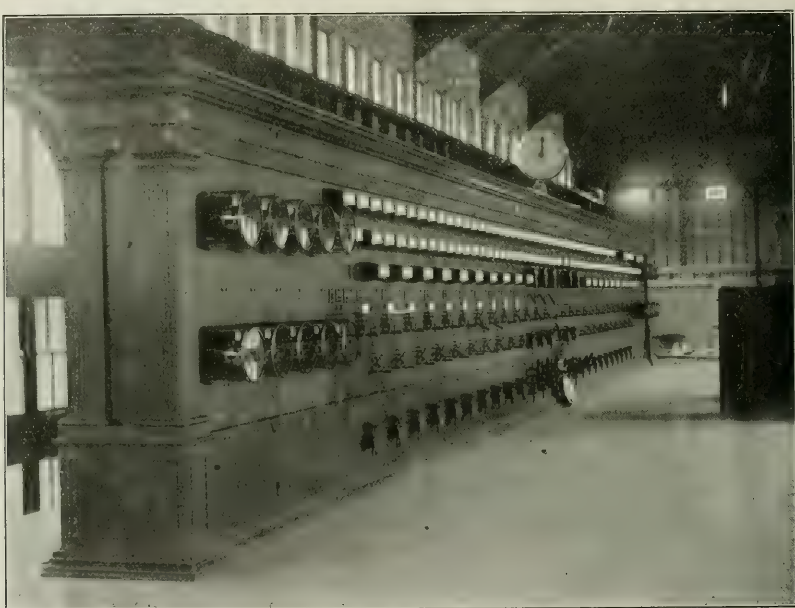
The forebay room is attached to the east side of the power house and has a flat steel and concrete promenade roof, with asphalt and tile floor.

Current is conveyed from the power house by conduits, one of which, 2,200 feet long, leads to a transformer station located outside the public park.

The turbines of the Canadian Niagara Power Company are twin inward discharge, Francis type of 10,000 h. p., three being built by Escher Wyss & Company, and two by the I. P. Morris Company. They operate at 250 r.p.m. under 136 feet net effective lead, and have brass runners 5 feet in diameter, and cylinder gates controlled each by four racks and pinions. The racks move on opposite sides of the pinions, so that one gate rises as the mate to it lowers, the whole movement for each unit being controlled by a connecting rod from the Escher Wyss governor situated on the power house floor.

The main penstocks each consist of a lower cast steel elbow in two sections, weighing 49 tons, which sits astride of the pit and carries the weight of the penstock and the water contained therein; above this are five straight sections of rivetted pipe ten feet two and a half inches in diameter, having weldless steel flanges, and an expansion joint connecting to the cast iron mouthpieces in wheelpit wall by a steel upper elbow. The calculated speed of the water with full load on a unit is about 11 feet per second.

Five units of 7,500 K. W. output each makes the present installation, but the plant, as previously stated, is built for eleven such machines, the eleventh being counted a spare. The 7,500 K. W. generators, which were furnished by the General Electric Company, are about 18 feet in diameter, with internal revolving fields, and deliver three-phase 25-cycle current at 12,000 volts.



CANADIAN NIAGARA POWER COMPANY—VIEW OF NO. 1 SWITCHBOARD.

The exciter turbines were supplied by the Jenckes Machine Company and the exciter generators by the Westinghouse Electric and Manufacturing Company. The Canadian General Company were the contractors for the transformers and the Canada Foundry Company for the various lift gates, etc.

For supplying the various water-driven machines in the chambers, an independent water system has been installed, which consists of a 36-inch rivetted main with weldless flanges, along the rack deck, fed from the canal by two 36-inch and five 24-inch vertical pipes.

THE SWITCHBOARD EQUIPMENT.

With the increase in size of generating units, as well as their number, installed in a power station, the problem of positive and rapid control of switching devices became more complicated and at the same time more necessary of solution. It was no longer possible to build switches for manual control and the air break types had to give way to those in which the arc was disrupted in oil. Moreover, with a greater number of generators, a corresponding increase in the number of switching devices and switchboard panels resulted, with the consequent danger of errors in switching. As is usually the case, many machines are running in multiple and the amount of power transmitted becomes very large, so that an error in switching is liable to damage much apparatus, besides shutting down the plant. To overcome these possible difficulties and to render switching devices more positive of action as well as to make them easier of manipulation, the multiple, auxiliary control, interlocking switchboard installed in the station of the Canadian Niagara Power Company is a fine example of the best switchboard practice.

Canadian Niagara Power Company Low Tension Switchboard.

Canadian Niagara Power Company—Interior of Transformer Building.

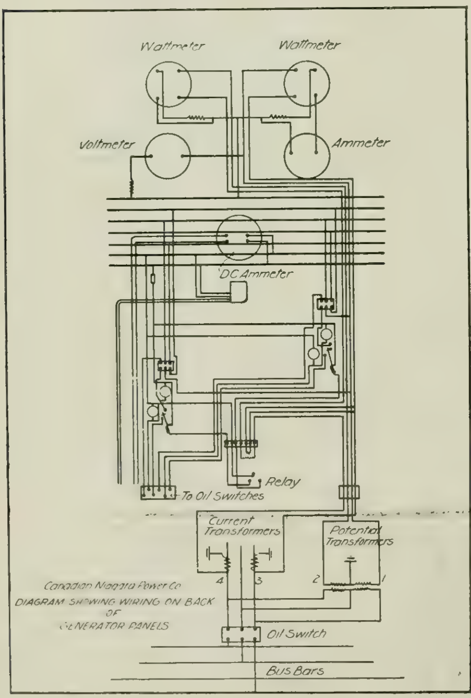
This main switchboard is shown in the photographic reproduction herewith. It stands upon the top of the vault in the generating room facing and controlling five 10,000 H.P. 12,000 volt 3-phase, 25 cycle generators. Each switchboard panel is of black dull finished slate in two parts. From left to right there are five integrating wattmeter panels with two integrating polyphase wattmeters to each panel, an inter-connecting panel, ten feeder panels, three generator panels, an

interconnecting panel, two generator panels, ten feeder panels, an interconnecting panel and five integrating wattmeter panels. The wattmeters measure the input into each feeder.

Each feeder and each generator panel connects with two type H automatic oil switches. These switches are motor controlled, the motors deriving their energy from the 125 volt direct current exciter circuit, selector switches being connected in between the bus-bars and the oil switches.

There are four sets of bus-bars, ten feeders being connected to buses Nos. 1 and 2 and ten connected to busses Nos. 3 and 4. Of the five generators, three are connected to buses Nos. 1 or 2 and two are connected to busses Nos. 3 or 4.

For the control of feeders and generator oil switches, two sets of dummy buses are run on the board, each bus having one Niagara type interlocking pilot switch. Each dummy bus on each panel has a synchronizing plug and socket connection. No pilot switch can be thrown unless the synchronizing plug has been inserted in the socket provided. A red and a green light are



provided on each dummy bus and for pilot switch on all panels. The red light burns when switch cannot be closed, whilst the green light will show when the reverse operation can be carried out.

Indicating wattmeters and ammeters are provided for each panel. In addition the generator panels have the usual voltmeters and rheostat handles. The rheostats in this case are motor controlled, placed in a vault beneath the floor line of the station. Each feeder and generator panel is further equipped with an overload relay as a further protection. No potentials of over 125 volts are carried on the main board shown. Beneath the main board is the vault or space provided wherein are grouped the sets of automatic oil switches, erected in a double row and separated from one another by suitable fireproof dividing walls.

A double set of exciter circuit bus-bars are provided, the generator panels having double throw single pole switches to utilize this duplicate arrangement. In addition an emergency board is utilized for the purpose of opening the field circuits of all generators running in multiple on any one bus. This operation is accomplished by the pressing of a button and is only made use of should the oil switch circuit breakers fail to operate for any reason.

In a separate building removed from the power station are installed the step up transformers. The present installation comprises twelve transformers of

Mr. Phillip P. Barton,
General Manager Canadian Niagara Power Company.

four banks of three each. They are each of 1250 k.w. capacity, oil insulated and water cooled. The primary and secondary windings are interchangeable, each winding consisting of five 11,000 volt coils and so arranged that 11,000, 22,000, 33,000, 37,000 or 57,000 volts can be obtained from the secondary side by a suitable change in the arrangement of coil connections, star to delta or vice-versa.

The 11,000 volt panels of the transformer switchboard shown in the illustration have for each panel, an ammeter in each leg, a non-automatic oil switch, selector switches and a double set of bus-bars overhead. The high tension panels have a double set of bus-bars overhead with selector switches and form H non-automatic oil switches for remote control. The motors operating the switches derive their current from the 125 volt exciter circuits.

MONTREAL STREET RAILWAY POWER HOUSE.

An important order has just been placed for the new power house of the Montreal Street Railway which is now in course of erection at Hochelaga, with Babcock & Wilcox, Limited, of Montreal, for ten of their well known water tube boilers, aggregating over 5,000 horse power, and equipped with their patent superheaters and chain grate stokers. This will be one of the most important power plants in Canada.

IMPROVED ENGINES.

The accompanying illustration is of one of two vertical engines built by the Goldie & McCulloch Company, Limited, Galt, Ont., for the Dominion Iron & Steel Company for their power house at Sydney, N.S. The valve motion of these engines is of the Corliss type similar in construction to the standard for horizontal engines made by this company, with steam actuated dash pots. This style of dash pot enables the engines to be run at a higher rate of speed than is usual with this type of engine. Both high and low pressure cylinders are fitted with separate eccentrics for actuating the steam and exhaust valves, and the cut-off of both cylinders is under the control of the governor. This latter feature is essential to the proper regulation and economy of engines operating on a greatly varying load and is especially desirable in a case where direct driven alternating current generators are to be run in parallel. If the low pressure cylinder is not so controlled but has a fixed cut-off, the division of load between the two cylinders will vary with every change of load ; the high pressure cylinder carrying the greater proportion of the total at light loads, and vice versa. As above stated, the closing of the admission valves is accomplished by steam pressure. When the valve is opened an extension of the dash pot spindle is pushed into a small steam cylinder against pressure and when released the valve is closed rapidly, giving a sharp cut off. The necessary cushion is effected by an air cylinder placed at the opposite end of the dash pot spindle. The top of this air cylinder is adjustable so that the latch plate arm on the valve spindle can be made to come to rest at its proper place. The steam and exhaust valves are double ported. The valve seats are lapped out and the valves ground to gauge. The edges of the cylinder ports are planed in a special planer. The oiling is effected from a central reservoir with pipes leading to the various places to be oiled.

The diameter of the high pressure cylinder is 21 inches ; the low pressure cylinder 42 inches and the stroke 30 inches. The speed is 150 revolutions per minute. The main bearings, which are fitted with removeable shells, are 14 inches diameter and 28 inches long. The crank pins are 6-3/4 inches diameter by 8-1/4 inches long. The fly wheel is 12 ft. diameter and weighs 32,000 pounds. The total height of this engine above the floor line is 19 feet. The governor

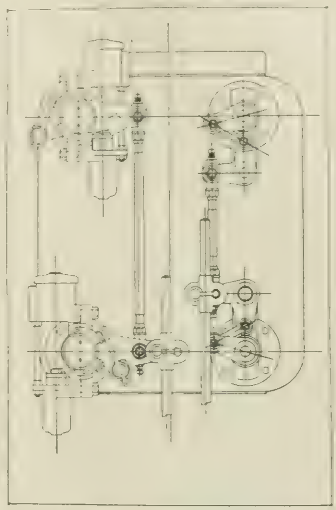


Fig. 2.—Valve Gear—H.P. Cylinder.

is of the "Rites" inertia type and is especially adapted for the parallel running of alternators and for other places where extremely close regulation and quick action are necessary.

The engines are direct connected to sixty cycle alternating current generators of 600 K.W. capacity.

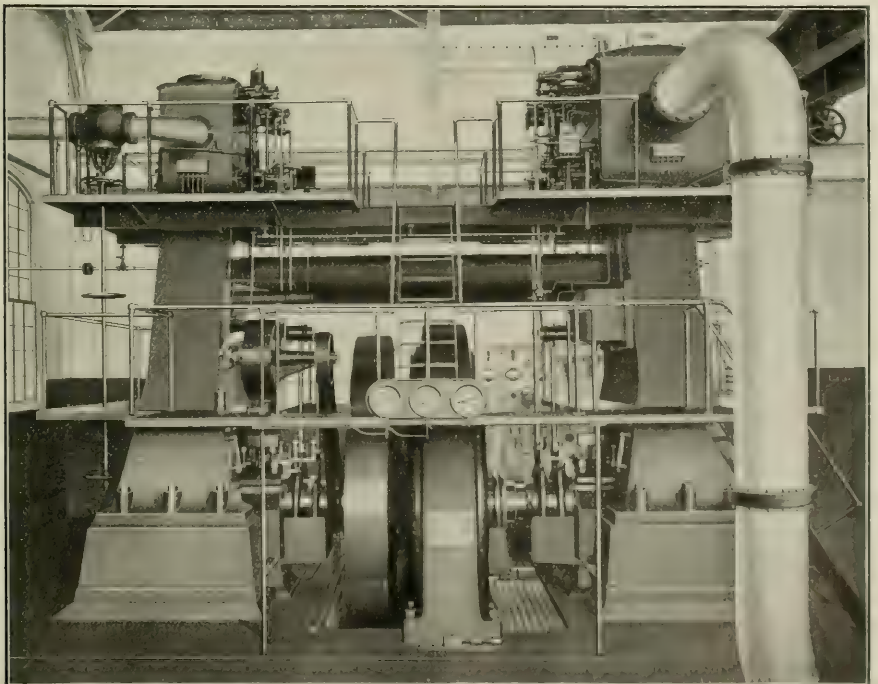


Fig. 1.—Pair of Vertical Engines Built by the Goldie & McCulloch Company.

CANADIAN

Electrical News

AND ENGINEERING JOURNAL

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ADVERTISEMENTS.

Advertising rates sent promptly on application. Orders for advertising should reach the office of publication not later than the 1st day of the month immediately preceding date of issue. Changes in advertisements will be made whenever desired without cost to the advertiser, but to insure proper compliance with the instructions of the advertiser, requests for change should reach the office as early as the 26th day of the month **for the succeeding month's issue.**

SUBSCRIPTIONS.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

CANADIAN ELECTRICAL ASSOCIATION

ONTARIO ASSOCIATION OF STATIONARY ENGINEERS.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

High Frequencies. Mr. Nikola Tesla has long been noted for his original investigations conducted in the field of high frequency experiments, and on the first occasion of his statement of its being possible for a person to receive a high-voltage, high-frequency discharge without sensation, the scientific world expressed great doubt of such a thing being possible. Very recently, however, a lecture was given in the city of Chicago by Professor W. I. Clarke, of Mount Vernon, New York, covering experiments with high frequency currents, and the demonstration made was certainly remarkable in character, and proved most conclusively that Mr. Tesla's contentions were real facts. Electric currents, either alternating or direct, of a pressure of 110 volts, have been demonstrated in many cases as practically harmless, no serious results being on record except in instances where the person shocked suffered from a weak heart. Pressures of five hundred volts and upwards are considered fatal, however, and it is rarely that a shock is received, with good contact, that more or less serious results do not follow. Of course, the higher the voltage the more certain are the chances of a fatal shock, provided the frequency is within the limits used in commercial work. While it has been shown that a current of one-quarter of an ampere flowing through the body is sufficient to cause death, still with the high frequency apparatus employed by Mr. Tesla and Professor Clarke, a current as high as one-half an ampere has been passed through the body without any sensation being felt whatever. In connection with these experiments, an extremely high voltage has been used. In most of the demonstrations, two men were connected in series across the terminals of the machine supplying the current, and between their disengaged hands various articles, such as incandescent lamps, Moore tubes, et cetera, were placed, such articles requiring a current of one-half ampere for their illumination. These lamps and tubes were lit to their full brilliancy. Another experiment was made in which a small piece of iron wire was held in place of the lamp, and this wire was melted and broken by the current which was flowing through it. All these experiments go to prove most remarkable characteristics in connection with high frequency current. While it is doubtful if such frequencies will ever be used in commercial work, still the fact that they are harmless to the human body gives them at once an important standing among the many remarkable phenomena observed in the science of electricity.

The Metric System. The Metric System agitation, having reached the American Institute of Electrical Engineers some time ago, has been taken up and reported upon in definite form, the matter having been referred to the membership for a vote as to whether or not Government legislation should be asked to make the Metric System compulsory. There were one thousand, six hundred and thirty-five votes cast, out of which one thousand, four

hundred and seventy-four, or over ninety per cent. were in favor of the Metric System. This goes to show most undoubtedly that there is an overwhelmingly large sentiment among electrical engineers in favor of a decimal system of some sort, and we presume that the vote was taken on the Metric System because at the present time no satisfactory substitute has been presented. It is a noteworthy fact that among scientists in the United States and Canada, the Metric System of weights and measures has been in use, and in practical use, for many years, and that when documents have been prepared for the public by these men, they have merely substituted the English system of measures for the particular occasion. All the original calculations, however, are carried out in the Metric System. Of course, a very strong objection to the Metric System comes from the manufacturers, who have built various articles to standards based upon the English system, and these manufacturers very justly protest against the adoption of a system which will throw thousands of their standards out. These concerns, however, are quite willing to admit the material advantages which would be obtained from a decimal system of any kind, and they approve of the Metric System solely because it has been developed upon a common-sense basis. If a system could be adopted taking our inch as the standard of length, our pound as the standard of weight, and our gallon as the standard of measure or capacity, such a system would not interfere with the standards now in vogue in Canada, the United States, and Great Britain, but the argument brought forward by the advocates of the Metric System is that such system has been adopted in many countries, and the disadvantages of the adoption of such a system in the English-speaking countries would be more than offset by the advantages obtained through the fact that the Metric System has already reached the plane of an international standard. Whatever the outcome of the present agitation will be, we are decidedly of the opinion that a decimal system of some nature will be adopted, and whether it will be the Metric System or a system developed from our own existing standards we are sure that decidedly beneficial results will be experienced.

Combined Power and Telephone Lines.

In various parts of the United States, the telephone companies and the electric light and power companies have come to agreements which have enabled them to utilize, in outlying districts, the same pole lines for supporting both electric light and telephone conductors. This brings forward a question of considerable interest, namely, which lines should be placed at the top of the pole, and which should be placed below the other. The construction adopted at various points in the States cannot be taken as a standard for similar work to be carried out in the future, inasmuch as the control of placing the wires has been in the hands of either one company or the other, and this company has decided upon the position of its own conductors to suit its own convenience, and without much consideration of the rights of the other party. In Canada, it is very seldom that a combination of power and telephone wires is seen upon one pole, it being the policy of the Bell Company to religiously avoid such construction in every possible case. The Bell Company also makes a practice of insisting that its wires be strung above all other conductors, and so far as its own experience is concerned, such policy has proved to be very satisfactory. From a purely engineering standpoint, the heavy wires should be strung at the top of the pole, in the building of a combination line, and the lighter wires should be strung beneath. The larger the wire, the less surface it presents to the action of the wind, compared to its cross-sectional area, and this certainly reduces the chances of breakage from this source. Sleet will form to the same thickness on wires of practically any diameter, and therefore the larger the cross-sectional area the less is the chance of a breakage occurring. It is on the telephone wires that most work has to be done, and if such wires are located on the tops of poles, it necessitates the lineman passing through the higher voltage power wires in order to reach the telephone circuits. On the other hand, the power wires require but little attention, and even in the event of the necessity for such work, the passage of a lineman through the telephone conductors can hardly be considered as a hazardous procedure. All these points, namely, the lower risk of breakdown, and the less personal danger, go to show that the proper place for the light and power wires is on the top of the pole, that is, admitting, of course, that a combination pole line is a desirable thing. So far as it is possible, it is certainly good practice to avoid such construction, but where it is not possible, then the combination of the two systems may be made, and if properly carried out, should not result in trouble. As before stated, the construction is now being used to a considerable extent in various localities, but the concern which owns the poles, or has the title to the right of way, seems to invariably say that its lines shall go on top, and if the other party wishes to use the same poles, he may place his wires as best he can, after paying for the privilege.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

The eleventh annual convention of the above Association will be held at New Haven, Conn., August 15, 16 and 17, 1906. At this meeting the following papers will be presented and discussed:

"History of the Fire Alarm and Police Telegraph." "Details of Certain Auxiliaries to Fire Apparatus." "Advisability of Protecting Municipal Electricians by the Civil Service Laws." "Comparison of Underground and Overhead Wiring, and of the Relative Values of Single, Rubber Covered Wire and Lead Encased Cable for Underground Construction." "Conditions Surrounding the Inspection of Wires in the Southwest." In addition to the above papers the Question Box will be a feature at this meeting.

MR. J. A. BURNETT.

Mr. J. A. Burnett has received the appointment of superintendent and electrical engineer of the Montreal & Southern Counties Railroad. This road is intended to connect the city of Montreal with the south shore of the province and will connect with St. Lambert and Longueuil, also Chambly. Running rights have been

MR. J. A. BURNETT,
Superintendent Montreal and Southern Counties' Railway.

secured from the Grand Trunk Railway over the Victoria Jubilee Bridge.

Mr. Burnett has been for some years with the Montreal Light, Heat & Power Company as construction engineer and has had a wide range of work. He has contributed interesting articles at different times to the columns of the ELECTRICAL NEWS and is an associate member of the Canadian Society of Civil Engineers and an associate member of the American Institute of Electrical Engineers, and occupies a well defined position in Montreal electrical circles.

MR. A. L. MUDGE.

Mr. A. L. Mudge, who has been appointed Estimating Engineer of Allis-Chalmers-Bullock, Limited,

MR. A. L. MUDGE.

Montreal, is one more Canadian who, after experience in the great industrial establishments of the United States, has returned to take a responsible position at home. After graduating from McGill University in mechanical engineering in 1894, and in electrical engineering in 1895, he spent one and one-half years with the Canadian General Electric Company, Peterborough, and afterwards some time with the Royal Electric Company, Montreal. From 1899 to 1901 he was electrical engineer for the Grand Trunk Railway System from Portland to Detroit. From Montreal he went to Pittfield, Mass., to take charge of construction work for the Stanley Electric Manufacturing Company. During the past two years he has been with the Allis-Chalmers Company, partly in the Bullock Electric Works, Cincinnati, and latterly in the head office, Milwaukee.

THE LATE MR. B. W. CHIPMAN.

We present herewith a portrait of the late Mr. B. W. Chipman, Secretary of Agriculture and President of the Nova Scotia Telephone Company, to whose death reference was made in the May number. Mr. Chipman was in his 71st year. He was born near Middleton,

THE LATE MR. B. W. CHIPMAN,
President Nova Scotia Telephone Company.

N. S., and began business life by establishing a hardware store in the town. He was on the original board of directors of the Nova Scotia Telephone Company, and in conjunction with Messrs. C. E. Fraser and B. F. Pearson, was intrumental in establishing the enterprise. The company was organized in 1887, with Dr. W.C. Delaney as its first president and a capital of $60,000. The venture was a success, its operations were soon extended, and to-day it has a capital of $650,000. On the death of Dr. Delaney, the late Mr. Chipman became president and under his direction the company made wonderful strides. He was appointed Secretary of Agriculture on the death of Prof. Lawson. Mr. Chipman leaves three sons and two daughters, Mrs. Chipman having predeceased him some years ago.

A by-law to ratify an agreement between the Town Council of Ingersoll, Ont., and the Independent Telephone Company received its second reading on June 4th.

A meeting of the directors of the Mexican Light, Heat & Power Company was held in Montreal early this month, at which a very satisfactory report of the company's business was submitted. There are now 15,000 horse power in use and an additional 5,000 unit have just been completed. Mr. James Ross was re elected as president.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstaces warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—Will you kindly tell me how to figure the size and height of chimneys for steam boilers.

Ans.—The first point to be considered in designing a chimney is the kind of fuel to be burnt, and the quantity which is to be consumed per square foot of grate surface per hour. According to data which has been published by Professor R. H. Thurston, the draft required for various fuels is as follows:

Ordinary steam coal	.4 to .75	inches of water
Ordinary slack	.6 to .9	" " "
Anthracite	1.25 to 1.5	" " "
Anthracite slack	1.3 to 1.8	" " "

Probably from the above you can ascertain the draft in inches of water which will be required to burn the coal you propose to use. Assuming a temperature for the gases discharged by the boiler of 600 degrees Fahrenheit, and a temperature for the outside air of 62 degrees Fahrenheit, the draft in inches is obtained by the following formula:

Draft equals height in feet x .007.

The constant .007 is derived from the temperature of the gases and the air, and will, of course, vary for other temperatures than those given. Assuming that you are to burn ordinary steam coal and adopting a stack of eighty feet in height, thus obtaining a draft of .56 inches of water, we find on making reference to data published by Professor Trowbridge that a chimney of this height is capable of burning 135 pounds of coal per square foot of chimney area. Assuming an evaporation in your boiler of eight pounds of water per pound of coal, and that the boiler is of 200 horse-power capacity, which on the basis of a consumption of 34½ pounds of water per horse-power per hour from and at 212 degrees Fahrenheit, is equivalent of an evaporation of 6,900 pounds per hour, this will mean that 862 pounds of coal per hour must be burnt on the grates. If an eighty foot chimney will burn 135 lbs. per hour, per square foot of grate section, then the necessary chimney for your boiler should be eighty feet in height and should have a net area of approximately six and one-half square feet. Figure out what the side of an equivalent square would be, and add four inches to this dimension. This is the allowance usually made for the friction between the gases and the sides of the chimney.

Ques. No. 2.—I wish to utilize the horse-power of an automobile, say 6 to 10 horse-power, without disturbance of the normal arrangement of the engine, to produce a direct or continuous current for a projecting arc lamp, say of 2,000 candle-power, by adding a generator. I presume this lamp would use 25 to 30 amperes. What is the best voltage and what gain is had from using say 110 volts in preference to lower pressures, say 50 to 75, and making rheostats necessary? Is resistance absolutely necessary to obtaining greatest light values? Is there any increase of light, due to increased voltage? Please give best form of dynamo, speed, etc. Is it possible to transform or alter an alternating current, say of 110 volts, to a direct current of the same pressure or the reverse?

Ans.—Candle-power rating is never used and cannot be used in connection with searchlights, it being impossible to measure the light from such a lamp by a photometer. Such lamps are always rated upon their energy consumption, and we would advise our correspondent that standard projectors of various sizes, both above and below the current consumption which he specifies, are as follows:

13 inches in diameter	20 amperes
18 " " "	35 "

The only reason that searchlights are equipped with rheostats is that they usually have to run on 110 volt circuits, and as this voltage is much too high for use in the lamp, a rheostat has to be introduced into the circuit for cutting down the voltage. The voltage across the carbon points of either of the lamps above specified will be between 45 and 50. Possibly ten volts will be taken up in the lamp mechanism, making a total voltage across the lamp proper of 60. This means that the remaining 50 volts must be taken up by the rheostat, and the energy which this represents is dissipated into the air in the form of useless heat, hence you will see that the operation of a projector on a 110 volt circuit is not economical, and that greater economy would be obtained if the lamp could be run from a circuit of lower voltage. If you are considering the purchase of a projector, we would advise you to take the point up with the manufacturers, and ascertain from them what the lowest voltage is which will give satisfactory operation in the lamp. There is no gain whatever in using more than 50 volts at the arc; in fact, with higher voltages the operation of the lamp would not be satisfactory. As the generator would have to be specially designed for driving from your automobile engine, we could not give you any information which would be of value, but would advise you to take this point up with various manufacturers, who may quite possibly have designs worked up for a machine which would suit your requirements. Thirty amperes at sixty volts is equal to 1.8 kilowatts. Assuming a generator efficiency of 60 per cent. this means that the input in power must be three kilowatts, or approximately four horse-power. From this you will see that the size of your engine is ample for driving the generator. Alternating current may be transformed to direct current or vice versa in two ways, namely, by a motor-generator set, or by a rotary converter. With the motor-generator set, the voltage of the imput current and output current are absolutely independent, and can be made any value desired, inasmuch as there are two entirely separate machines, that is to say, separate from an electrical standpoint. The alternating or direct current, as the case may be, goes into one machine which is a motor, and which is wound for the voltage and current of the circuit. The input energy is transformed into mechanical motion, and is delivered in this form to the shaft of the other machine, which will be a generator, wound to deliver either direct or alternating current of the desired pressure. With the rotary converter, however, the ratio between the direct current and the alternating current is pretty rigidly fixed. In transforming 110 volts direct current to single-phase alternating current, the voltage on the alternating current end will be approximately 78, and if three phase current be taken from the alternating end of the converter, a slightly lower voltage will be obtained. On the other hand, if 110 volts are fed into the alternating current end of a rotary converter, the resultant direct current voltage will be about 156.

A NEW POWER DEVELOPMENT.

By J. F. H. Wyse.

Of special interest to the electrical fraternity, power users and manufacturing industries is the proposed installation at Senator Mitchell's Chignecto coal mines in Nova Scotia.

It is gratifying that this plant as contemplated by the Maritime Coal, Railway & Power Company, of which Senator Mitchell is President, and designed to transmit power to Amherst, Moncton and intermediate towns, has the commendation of Mr. Thomas Alva Edison. Mr. Edison in an interview recently with Mr. James Creelman said : "It would not surprise me to learn that some one had seized the secret of the production of electricity by direct process. This will abolish the carrying of coal for the production of electricity. Instead of transporting such gross material as coal to get power we shall set up plants at the mouth of mines and generate the power there and transmit it wherever it is needed by copper wires.

"It is preposterous to keep on putting the coal mines on wheels, it is too clumsy, too costly and there is no necessity for it. It is easier to convey molecular vibration—millions of waves a second—than freight cars full of crude matter. We can ship one hundred thousand horse power over a wire more quickly and more economically than we can send the equivalent in coal over a railroad track.

"We must eliminate the railroad altogether from this problem ; what we want is the resultant, the utmost energy that can be produced. Everything points to the fact that in the near future electricity will be produced for general consumption in great power houses at the mouths of the coal pits. This is the logical and common sense outcome of present events.

"Now, the truth is that it will cost one-third less to transport electrical power by wire than to convey it in the form of coal in railroad cars. We can turn that coal into electricity at the mine and convey it by wire at less than half the cost of freighting coal."

Where water powers are not available, the great power plants will be set up in the coal fields, and do away with individual steam plants and electric light will become cheaper than gas.

The natural advantages of Amherst and indeed the entire surrounding country are remarkable. Its enormous coal and iron supply, its proximity to the British markets and the New England cities, is a guarantee of its rapid advancement as a manufacturing centre. The cheap power that is being supplied to towns in other sections of the country by water developments, here will have the more reliable power developed from coal. The well known troubles incident to water power plants such as anchor ice in the winter, floods in the spring, and later, droughts in the summer, will be entirely eliminated by power to be transmitted from the Chignecto Mines.

A similar plan in Lancashire, England, has been commercially successful, and it is a debatable question, everything carefully considered, if coal power under these conditions is not as cheap in the long run or cheaper than that produced from water.

At the mouth of the Chignecto Mines, where there is an inexhaustible supply of coal, the product of the mine run embraces about 20% of a grade of coal so cheap that it does not pay to transport it by rail. This coal, however, must be removed from the mine with that of better grade. The power development, with up-to-date mechanical stokers, will for some time to come be supplied economically with what now is practically refuse.

The transmission lines will deliver the power directly to the manufacturer at Amherst, about six miles from the mine, where the benefits will be at once felt in an installation of motors at a much smaller capital expenditure than boilers, engines, shafting, etc., etc., effecting also a vast economy in floor space, the motors often being suspended directly from the ceiling.

Main Street, Amherst, N. S.

A few of the items of economy are, utilizing a refuse coal, saving of transportation on same, the saving incident to generating power in one large unit in comparison with a number of small plants, that of distribution to individual machines at a comparatively nominal loss as against the loss (from 20% to 80%) of distribution by shafting, and the enormous saving to the consumer by the expense ceasing when individual motors are shut down in the factories, or the motor plant shut down for the night ; to say nothing of the greater convenience and cheaper insurance rates.

Coal Mines at Chignecto, Nova Scotia.

There is now a market at Amherst alone of eleven big manufacturing concerns, aggregating a cost of some $116,000 per annum for power, who will adopt electricity. The town will use the current for pumping its water supply and for lighting.

There is every reason to believe that this enterprise will in time rival in size, by the attraction of new enterprises to its vicinity, such gigantic water power developments as Niagara Falls and Shawinigan.

MONTREAL

Branch Office of CANADIAN ELECTRICAL NEWS,
Room B34 Board of Trade Building.

June 9th, 1906.

In your May issue it is seen that Ottawa is having its troubles re inspections. Ottawa must know that the Underwriters need the money, and so long as they can stick the Power Company to do the inspecting (as is the case in Montreal), then our Ottawa friends are up against the same proposition that we have in Montreal. In fact, our case here is a little worse, and the city a little larger.

It is comforting to hear from Mr. Strickland in the May issue that fires are put down to electricity in Toronto without proof, as has long been the case in the daily press in Montreal in a similar manner. Mr. Strickland is in a position to know, but electrical firms have the cure in their own hands, viz., to refuse advertising to such papers as make a practice of hurting the industry.

Since the recent verdict against them, the Montreal Light, Heat & Power Company, in the absence of other inspection, have caused their own inspectors to take strict note that all wiring is in accordance with Fire Underwriters rules, and also safe as regards life, before making connection to any job. This will help some, but just why the Power Company should be forced to do work that the Underwriters reap the profits upon is hard to figure out. What is the matter with the Underwriters any way, surely Montreal can follow the steps of Boston, Philadelphia, New York, Chicago, etc., to advantage!

The electrical arrangements installed by order of Sir H. Montagu Allan, "Ravenscrag", in the pavilion erected for the reception and dinner on the occasion of Prince Arthur's stay in Montreal, were on a scale not generally undertaken by private individuals, more especially when it is understood that the arrangements were made for the space of two nights only. Two special circuits were run in by the Montreal Light, Heat & Power Co., one consisting of 37 kilowatts at 110 volts, A. C., (which was used on the interior decorative lighting and plate-warming table), whilst the other circuit, 250 volts D. C., was used for radiators which heated the building. The Montreal Electric Company had charge of all interior installation and secured from the Montreal Street Railway Company twelve of their car heaters. The lighting consisted of festoons outlining the interior cornices of the building, using up some 300 lamps, whilst the plate-warming table consisted of a lamp bank enclosed in a galvanized iron box protected with asbestos, 10 feet long by 3 feet wide. The Montreal Electric Company had a couple of men on patrol duty the whole evening, and report that there was no hitch—not even a fuse blown out.

The Montreal Light, Heat & Power Company have had a verdict rendered against them of $7,000 for causing the death of a man recently at St. Lawrence St. North. It is an understood thing that juries generally award cases against large corporations; but, nevertheless, in this case there were certainly extenuating circumstances, as a long cord was in use of old code type, coupled up to a brass socket, in a shed often liable to considerable moisture. True, the transformer must have been punctured, but it seems strange that the man did not receive shocks at the normal voltage before this time under the conditions existing.

ELECTRICAL TRADES EXHIBITION.

Mr. E. W. Sayer, of the Sayer Electric Company, has with commendable energy launched the preliminary steps for an Electrical Trades Exhibition to be held in Victoria Rink during the month of September. The work of advertising, circulars, etc., has been taken hold of in thorough business like shape, and there is every reason to believe that the Exhibition will be a success. The Electrical Contractors Association have assured Mr. Sayer of their goodwill and will give him all the assistance that they can without infringing upon the By-laws of the Builders' Exchange to which they belong as a section. Although the officers of the Contractors' Association have been mentioned in connection with this Exhibition in the daily press, yet the entire arrangements have been made by Mr. Sayer, who in fact is handling the Exhibition in question, and he is entitled to the sole credit as his due. Spaces have already been marked off on a printed plan of the Rink, and even before they were officially placed on sale three or four of such had already been spoken for. It is so many years since an Exhibition of this sort was held in Montreal that this will be a splendid opportunity to bring recent novelties before the public eye.

ELECTRIC POWER SUPPLY AT WINNIPEG.

Winnipeg has a large proposition on hand in connection with the supply of electric power, and several proposals have been made to the city to bring in power from the outlying available water supply. That Winnipeg can get all the electrical power likely to be needed is absolutely certain. However, there is a difference of opinion as to whether the city's proposed municipal power plant would be better than Mr. J. D. McArthur's proposition, or the proposition of the Winnipeg Electric Street Railway Company. The expert engineer on the McArthur proposition is Mr. Alexander MacDougall, and the latter disputes with Col. Ruttan, the city engineer, on various points connected with the proposed electrical developments.

The offer from Mr. J. D. McArthur, which was to show how much cheaper power could be obtained under private ownership than under public ownership, has been presented to the Council. Mr. McArthur offers to supply the first 10,000 horse power for $26 per horse power per annum; the second 10,000 h.p. for $23; the third 10,000 h.p. for $18; the fourth 10,000 h.p. for $16; and the fifth 10,000 h.p. for $14. These prices, it must be understood, do not include the cost of distributing the power to the manufacturers. That cost must be added to the prices that Mr. McArthur names.

It will be seen from the prices quoted above that, if the city used 50,000 horse power, the average cost would be $19.40. If the city used 40,000, the cost would be $20.75. If the city used 30,000, the cost would be $22.33 1/3. If only 20,000 were used, it would cost the city $24.50.

It must be borne in mind that it will be a long time before Winnipeg will require 50,000 horse power, besides that which is now being developed by private companies for their own use. It is certain that it will be some years before more than 20,000 will be required.

The prices, then, which Mr. McArthur proposes to charge should be based on a supply of 30,000 h.p.—not on 50,000.

According to the estimates which were published on the fourth of May, the first 17,000 horse power can be delivered in Winnipeg at the same point where Mr. McArthur proposes to deliver his, if this offer should be accepted at $18 per horse power—$1.40 per horse power cheaper than Mr. McArthur's price for 50,000.

For 34,000 h.p. the experts the city employed estimate the cost at $13.87 per horse power—$5.53 per horse power cheaper than Mr. McArthur would charge if 50,000 were used.

For a development of 50,000 horse power the city's experts estimate the cost at $12.46 per horse power—$6.94 per horse power cheaper than Mr. McArthur would charge for the same supply.

Here is a paragraph from Mr. McArthur's letter, which deals with the cost of the private plant:

"Returning to the cost of the two developments, we are prepared to deliver to the city of Winnipeg a complete plant of 10,000 horse power, delivered in the city, at one million five hundred dollars. We are prepared to deliver 17,000 horse power in the city for two million three hundred thousand dollars. We are prepared to deliver 34,000 horse power in the city for the sum of three million six hundred thousand dollars. We are prepared to deliver 50,000 horse power at a cost of five million one hundred thousand dollars."

The expert who reported on the cost of a municipal plant, on behalf of the city, estimated that the total cost of the plant, including interest on the money during construction, engineering expenses, and 10% for contingencies would be, for 17,000 horse power capacity, $3,112,726; for 34,000 horse power capacity, $4,337,820; for 50,000 horse power capacity, $6,210,180.

The following recommendations have been made by Mr. F. A. Cambridge, City Electrician of Winnipeg:—

1—Building of new sub-station and centralizing of work of department.

2—Immediate insulation of fire alarm wire in business district in conduits.

3—Adoption of modern regulations as to rights of companies to construct pole and wire lines.

4—Action regarding electrolysis induced by tracks of street railway.

The annual report of the Winnipeg Electrical Engineers shows plainly the remarkable growth of the city. Before the current is turned on there is a final inspection of all new hands. The following is the record of inspection from May 1, 1905, to April 30, 1906: Permits for wiring, 3,691; permits for use of current, 3,026; arc lamps installed, 304; horse power motors and dynamos installed, 2,918; outlets wired, 47,193; inc. lamps installed, 44,875.

LARGE INTERPOLAR GENERATOR.

The largest interpolar generators ever put into operation and the first of their kind in Canada are notable features of the power house of the Northern Aluminum Limited, of Montreal, are in sets of two, driven by water wheels in the centre. There is, unfortunately, not enough spare space in the building to obtain a satisfactory view of the layout, but the generator shown

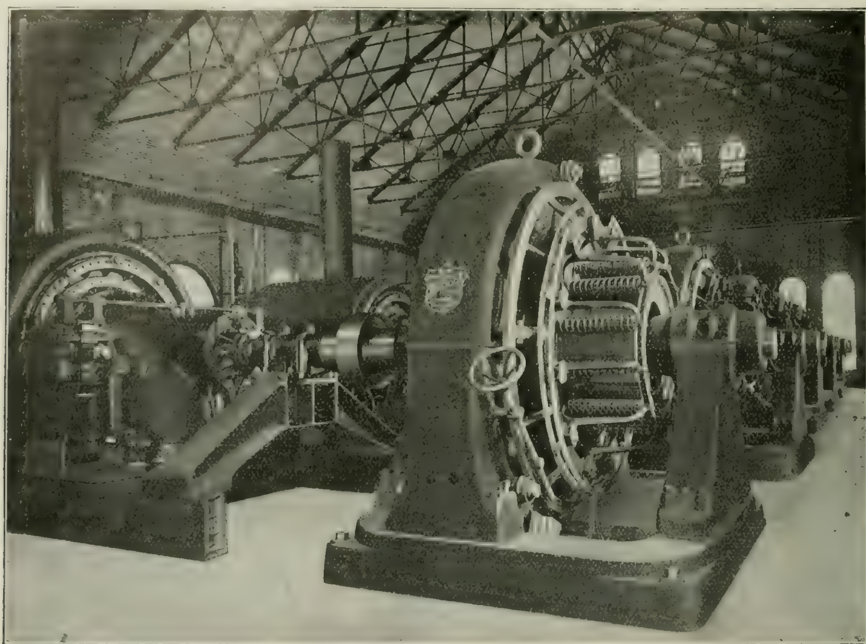

FIG. 1.—POWER HOUSE OF THE NORTHERN ALUMINUM COMPANY, LIMITED, SHAWINIGAN FALLS, QUE.

Company, Limited, of Shawinigan Falls, Que., shown in Fig. 1. Their original rating was 940 k.w., 365 volts, 2570 amperes, 250 r.p.m., but they are now in in Fig. 2 is one of those on the left of the water wheel shaft. The first generators that were installed were so successful that the company ordered four more of the

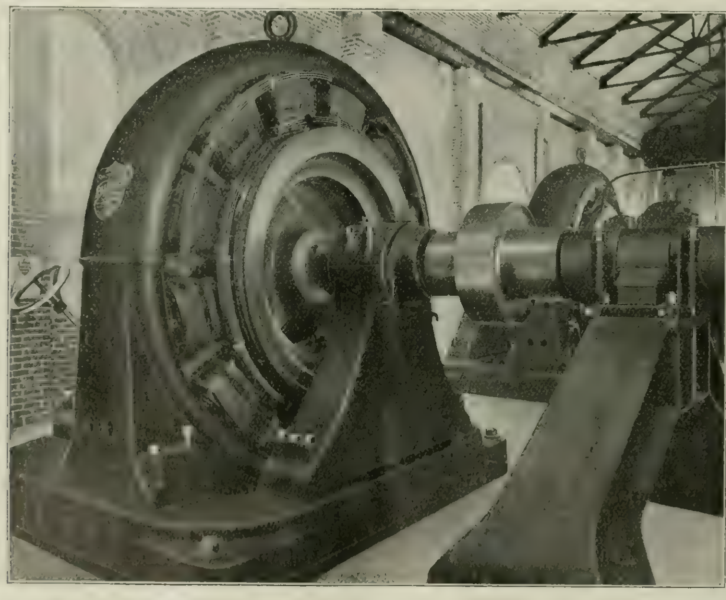

FIG. 2.—ONE OF THE 940 K. W. INTERPOLAR GENERATORS IN THE POWER HOUSE OF THE NORTHERN ALUMINUM COMPANY, LIMITED, SHAWINIGAN FALLS, QUE.

successful operation under a load of 2570 amperes at 425 volts with perfect commutation conditions.

These generators, built by Allis-Chalmers-Bullock, same capacity from Allis-Chalmers-Bullock, Limited. All of these machines have been in operation for over three months and give complete satisfaction.

CANADIAN

ELECTRICAL NEWS

AND

ENGINEERING JOURNAL

VOL. XVI. | JULY, 1906 | No. 7.

R. G. BLACK, Toronto, President

R. S KELSCH, Montreal, First Vice-President

W. N. RYERSON, Niagara Falls, Second Vice-President

T. S. YOUNG, Toronto, Secretary-Treasurer

OFFICERS OF THE CANADIAN ELECTRICAL ASSOCIATION, 1906-1907

CANADIAN ELECTRICAL ASSOCIATION OFFICERS.

Mr. R. G. Black, the new President of the Canadian Electrical Association, is the chief electrical engineer for the Toronto Electric Light Company. He received his early education in the public and high schools, taking the mechanical engineering course at the School of Practical Science, Toronto. Since graduating he has been connected with several large electrical companies in the United States and Canada and is at present laying out new work in connection with the distribution of Niagara power in Toronto.

Mr. R. S. Kelsch, First Vice-President, is the well known consulting engineer of Montreal. He has been closely associated with electrical development work in that city, being connected with both the Lachine Rapids Hydraulic & Land Company and the Montreal Light, Heat & Power Company, as well as many other important plants throughout Canada.

Mr W. N. Ryerson, the Second Vice-President, who is probably not so well known to Canadians, is superintendent of the Ontario Power Company and the Niagara Construction Company. He was born in New York City and completed his electrical engineering course at Columbia University in 1896. He was with the Sprague Electric Elevator Company and the Western Electric Company for some time and spent three years in the electrical department of the Metropolitan Street Railway, New York, in connection with the construction and operation of power and sub-stations. In 1902 he went with the Manhattan Railway Company as chief operator of main generating station and was later made superintendent of sub-stations for that company. He held the same position with the Interborough Rapid Transit Company when they leased the Manhattan Railway Company, and had entire charge of building and operating all the sub-stations of the Manhattan (elevated) system and also

A. A. Dion, Ottawa.

C. B. Hunt, London.

Lewis Burran, Quebec.

H. O. Fisk, Peterboro.

L. W. Pratt, Brantford.

J. W. Purcell, Walkerville.

MEMBERS OF THE EXECUTIVE COMMITTEE, CANADIAN ELECTRICAL ASSOCIATION.

of the sub-way, fifteen sub-stations in all. In the spring of 1905 Mr. Ryerson was appointed assistant superintendent of the Niagara Construction Company, who built the entire plant of the Ontario Power Company, and a few months later was made superintendent of the latter company.

The Executive Committee is composed of men who have the interests of the Association at heart, and we may safely predict that when the annual convention of 1907 is reached the report will show a good year's work.

J. J. WRIGHT, Toronto.

J. M. ROBERTSON, Montreal.

B. F. REESOR, Lindsay.

W. WILLIAMS, Sarnia.

MEMBERS OF THE EXECUTIVE COMMITTEE, CANADIAN ELECTRICAL ASSOCIATION.

ELECTRICAL TRADES EXHIBITION.

Jsut as this number of the ELECTRICAL NEWS is going to press, we are advised that the promoters of the Electrical Trades Exhibition announced to be held in Montreal in September have decided to postpone the Exhibition until a later date, in order that more time might be given for the preparation of exhibits.

LARGE GENERATORS PREDICTED.

Mr. B. A. Behrend, chief electrical engineer of the Allis-Chalmers Company, in a lecture delivered before the Engineering Department of the University of Wisconsin, stated that the next few years would see electrical generating units as large as 25,000 kilowatts or 32,000 horse power capacity. These gigantic generators, he believes, will follow as a natural evolution resulting from the introduction of the steam turbine, a form of prime mover which with its high peripheral speeds of three and four miles per minute, lends itself readily to units of great capacity. In his opinion the mammoth generators of the future will develop current at a potential of 30,000 volts. Units such as he refers to have three times the capacity of the largest existing apparatus.

The Delhi Light & Power Company, Delhi, Ont., are building a new dam.

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AND ENGINEERING JOURNAL

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Advertising rates sent promptly on application. Orders for advertising should reach the office of publication not later than the 1st day of the month immediately preceding date of issue. Changes in advertisements will be made whenever desired without cost to the advertiser, but to insure proper compliance with the instructions of the advertiser, requests for change should reach the office as early as the 26th day of the month for the succeeding month's issue.

SUBSCRIPTIONS.

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Subscribers are requested to promptly notify the publishers of failure or delay in delivery of the paper.

EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

CANADIAN ELECTRICAL ASSOCIATION

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J. J. WRIGHT, Manager Toronto Electric Light Company, Toronto.
W. WILLIAMS, Gas & Electric Light Co., Sarnia, Ont.
LEWIS BURRAN, Quebec Railway, Light & Power Co., Quebec.
H. O. FISK, Peterboro Electric Light Company, Peterboro.
J. W. PURCELL, Hiram Walker & Sons, Walkerville.

Canadian Electrical Association Convention. This number of the ELECTRICAL NEWS is largely given up to a report of the proceedings of the Sixteenth Annual Convention of the Canadian Electrical Association. The report will be found interesting and instructive reading. Five splendid papers were presented, each of which created discussion which brought out much valuable information. The hydro-electric plants at Niagara Falls represent the most advanced engineering principles, and consequently persons connected with plants of more moderate proportions were anxious to learn of the methods and materials that have been adopted towards securing reliability and economy in operation. Mr. Farmer's paper on "Steam Plant Accessories" appealed strongly to the operators of steam plants and will no doubt be carefully studied by central station managers and engineers who believe that the conditions under which they are operating can be improved. The paper by Mr. McKay was of general interest, inasmuch as it gave a concise explanation of many legal points heretofore obscure. Some time was this year devoted to the Question Box, which is undoubtedly a step in the right direction. Under Mr. Dion's able guidance, the Question Box has become a most valuable feature, and we hope that its usefulness will continue to increase as the result of more general participation by the members. The meeting place for the next convention was left with the Executive Committee. Montreal has been suggested. If the Association is to be recognized as representative of the electrical interests of the Dominion, the question of holding a convention in Winnipeg, and perhaps one in St. John or Halifax, is worthy of consideration.

Dampness in Electrical Apparatus The possibility of electrical apparatus becoming damp during transportation, or even after it has been installed in service, should be watched with the greatest care by all persons concerned in either the building of a plant or its subsequent operation. While such precautions apply with great strength where high tension apparatus is used, still the necessity for proportionate care in the case of low tension machinery also exists. As apparatus is built and put up for shipment at the present time, the chances of the entrance of moisture are more or less remote, but wherever doubt exists in such a case, all such questions should be absolutely eliminated before such apparatus is subjected to its working voltage. It would be well if manufacturers would furnish to their construction men data covering the insulation resistance of all electrical apparatus sent out on any particular piece of construction work, so that checks could be made on the insulation before the apparatus is worked. Should this insulation be found to be below that obtained at the point of manufacture, then the erection man should proceed at once to bring the resistance back to its proper point. It is very rarely that a baking oven, or even a substitute therefor, can be obtained on the premises of a new plant, and therefore the drying out will have to be done by electrical means. Great care should be taken in this work, of course, that the currents used are not excessive, and the attendant should have before him suitable means of checking the insulation resistance at regular intervals during the process of drying out. These readings should be plotted in the form of a curve, for this is really the only way for ascertaining the true condition of the insulation. If more care were exercised in connection with this particular feature, there would be fewer breakdowns in new electrical apparatus, and in all probability the regular checking of the insulation resistance of machinery in constant service would do much to prevent similar trouble.

At a special meeting of the City Council of Windsor, Ont., on June 23rd, the Windsor, Essex & Lake Shore Electric Railway, at present under construction from Windsor to Leamington, and within two years to be extended to Chatham, was given a fifty-year franchise through the city and was permitted to use "T" rails, but is to substitute girder rails after three years if the city so orders.

Canadian Electrical Association

Proceedings of Sixteenth Annual Convention

THE Sixteenth Annual Convention of the Canadian Electrical Association was held at Niagara Falls on Tuesday, Wednesday and Thursday, June 19, 20 and 21, 1906. The President, Mr. A. A. Wright, M. P., occupied the chair and called the convention to order at two o'clock p.m.

There were present the following persons:

A

W. K. Adams, Montreal, Crescent Electric Co.
J. G. Archibald, Woodstock, Ont., Woodstock Electric Light Co.
W. M. Andrew, Toronto, Canadian Westinghouse Co.
J. C. Armer, Toronto, "Canadian Machinery."
W. L. Adams, Niagara Falls, Ont., Ontario Power Co.

B

T. J. Bostwick, Niagara Falls, N. Y., Pittsburg Reduction Co.
H. D. Bayne, Montreal, Canadian Westinghouse Co.
H. A. Burson, Montreal, Allis-Chalmers Bullock Co.
R. G. Black, Toronto, Toronto Electric Light Co.
T. Beecroft, Barrie, Ont., Barrie Electric Light Co.
H. E. Brown, Toronto, Canadian General Electric Co.
L. T. Barclay, Whitby, Ont., Commissioner.
E. M. Breed, Montreal, Canadian Westinghouse Co.
N. S. Braden, Hamilton, Canadian Westinghouse Co.
D. P. Burke, Ottawa, Ottawa & Hull Power & Manufacturing Co.
L. Burran, Quebec, Quebec Railway, Light & Power Co.
G. W. Brooks, Schenectady, N. Y., General Electric Co.
G. E. Brown, Niagara Falls, Ont., Canadian Niagara Power Co.
L. G. Bassett, Buffalo, N. Y., Westinghouse Co.
O. S. Blakeley, Niagara Falls, N. Y., Bureau of Publicity.
W. A. Bucke, Toronto, Canadian General Electric Co.
B. G. Berg, Hamilton, Hamilton Steel & Iron Co.
V. Boyd, Toronto, Canadian General Electric Co.
E. D. Brand, Berlin, Ont., Berlin Electrical Manufacturing Co.
G. C. Burnham, Toronto, Allis-Chalmers-Bullock Co.

C

F. A. Chisholm, St. Johns, Que., St. Johns Electric Light Co.
J. H. Cragin, Niagara Falls, Ont., Oneida Community Limited.
P. S. Coate, Chatham, Ont., Chatham Gas Co.
J. W. Campbell, Toronto, Canadian General Electric Co.
V. B. Coleman, Port Hope, Ont., Port Hope Electric Light & Power Co.
A. Collyer, Montreal, Allis-Chalmers-Bullock Co.

D

J. B. Dougall, Barrie, Ont., Barrie Electric Plant.
A. A. Dion, Ottawa, Ottawa Electric Co.
Milton Delano, Toronto, Consulting Engineer.
Orrin E. Dunlap, Niagara Falls, N.Y.
R. J. Dunlop, Toronto, Canadian Westinghouse Co.
T. F. Dryden, Toronto, Canadian Westinghouse Co.
J. M. Deagle, Orangeville, The Cataract Electric Co.
A. Dunlop, Montreal, Duncan Electric Manufacturing Co.
A. T. Duncan, Brantford, Ont., Western Counties Electric Co.
Fred Deagle, Eugenia Falls, Ont., Georgian Bay Power Co.
J. D. Downer, Chicago, Ill., "Western Electrician."

E

F. Evans, Cleveland, Ohio, National Electric Lamp Co.
E. A. Evans, Quebec, Quebec Railway, Light & Power Co.
H. O. Edwards, Toronto, Canadian General Electric Co.
A. Esling, Toronto, R. E. T. Pringle Co.
W. H. Eisenbeis, Toronto, Canadian Westinghouse Co.

F

Edward P. Fetherstonhaugh, Montreal, Que.
H. O. Fisk, Peterboro, Ont., Peterboro Light & Power Co.
A. E. Fleming, Hamilton, Ont., Canadian Westinghouse Co.
J. A. Fletcher, Toronto, R. E. T. Pringle Co.
Thomas R. Fulton, Montreal, E. F. Phillips Electrical Works.
George F. Foot, Hamilton, Canadian Westinghouse Co.

G

Robert Gordon, Revelstoke, B.C., Electric Light Department.
Roy A. Gowdy, Montreal, Allis-Chalmers-Bullock.
John G. Glassgo, Hamilton, Hamilton Cataract Power, Light & Traction Co.
George Grosz, Waterloo, Ont., Waterloo Electric Light Co.

H

P. H. Hoover, New York, New York Insulated Wire Co.
L. St. J. Haskell, Kincardine, Ont., Corporation Electric Plant.
H. U. Hart, Hamilton, Canadian Westinghouse Co.
A. T. Hicks, Trenton, Ont., Trenton Electric & Water Power Co.
F. Hoffmeister, Toronto, Canadian General Electric Co.
R. B. Hamilton, St. Catharines, Ont., Packard Electric Co.
J. Herbert Hall, Toronto, Conduits Company, Limited.
P. E. Hart, Toronto, Canadian General Electric Co.
G. M. Harrington, Niagara Falls, N.Y., Niagara Falls Power Co.
W. D. Hall, Montreal, Grand Trunk Railway System.
Charles B. Hunt, London, Ont., London Electric Co.
M. C. Huyette, Toronto, Murphy Iron Works.
George Hillyard, Sudbury, Ont., Corporation Plant.
C. W. Henderson, Montreal, Canadian Westinghouse Co.
D. F. Hanna, Toronto, "Telegram."
Ludlow Haskell, Montreal, McGill University.
A. O. Hunt, London, London Electric Co.

I

E. Irving, Toronto, General Manager Sunbeam Incandescent Lamp Co.
D. Irving, Toronto, Sunbeam Incandescent Lamp Co.

J

J. K. Johnston, Electric Light Inspector, Toronto.
James Johnston, Ottawa, Public Works Department.
E. J. Jenking, Toronto, Canadian General Electric Co.

K

R. S. Kelsch, Montreal, Consulting Engineer.
C. G. Keyes, Hamilton, Ont., Canadian Westinghouse Co.
H. P. Kimball, New York, Standard Underground Cable Co.
A. E. Kinsley, Niagara Falls, Ont., Oneida Community, Limited.
John Knox, Hamilton, Western Counties Electric Co.

L

A. B. Lambe, Toronto, Canadian General Electric Co.
William Langford, Montmorency Falls, Que., Quebec Railway, Light & Power Co.
W. A. Lewis, Montreal, J. A. Dawson & Co.
W. W. Lovell, Toronto, Canadian Westinghouse Co.
T. D. Lonergan, Quebec, Quebec Electric Co.
J. D. Lachapelle, Sorel, Que., Elec. Eng. Richelieu & Ontario Navigation Co.

M

Alister Maclean, Montreal, Robb Engineering Co.
R. T. MacKeen, Toronto, Canadian General Electric Co.
R. H. Martindale, Sudbury, Ont., Corporation Plant.
John S. MacLean, Montreal, Allis-Chalmers-Bullock.
C. H. Mortimer, Toronto, Secretary Canadian Electrical Association.
John Murphy, Ottawa, Dept. of Railways and Canals.
Paul J. Myler, Hamilton, General Manager Canadian Westinghouse Co.
E. D. McCormack, Toronto, Canadian General Electric Co.
A. F. Moray, Tweed, Ont., Tweed Electric Light & Power Co.
Ray H. Manwaring, Philadelphia, Pa., The Philadelphia Elec. & Mfg. Co.
W. F. MacLaren, Hamilton, Canadian Westinghouse Co.
D. O. McKinnon, Toronto, "Canadian Manufacturer."
G. C. Mooring, Toronto, Modern Machine Co.
W. McCaffrey, Toronto, Canadian General Electric Co.
J. M. McLennan, Lindsay, Ont., President Light & Power Co.
William McKay, Toronto, Robb Engineering Co.
Robert McKay, Toronto, Johnston, McKay, Dods & Grant.
Edward B. Merrill, Toronto, Toronto & Niagara Power Co.

N

William Needler, Lindsay, Ont., Light, Heat & Power Co.
M. K. Ney, Montreal, Montreal Light, Heat & Power Co.

P

J. W. Purcell, Walkerville, Ont., Hiram Walker & Sons.
Louis W. Pratt, Brantford, Western Counties Electric Co.
Thomas L. Phillips, St. Catharines, Packard Electric Co.
C. U. Peeling, Bobcaygeon, Ont., Corporation Plant.
J. W. Pilcher, Montreal, Canadian General Electric Co.
E. J. Philip, Berlin, Ont., Superintendent Corporation Plant.
H. Pim, Vancouver, B.C., Canadian General Electric Co.
F. J. Parkin, Toronto, Canadian General Electric Co.

R

B. F. Reesor, Toronto, Manager Georgian Bay Power Co.
Donald Ross, Barrie, Ont., Barrie Electric Plant.
H. P. Rust, Niagara Falls, Ont., Electrical Development Co.
W. N. Ryerson, Niagara Falls South, Ont., Supt. Ontario Power Co.
F. Rose, Toronto, Canadian General Electric Co.

George C. Rough, St. Catharines, Ont., Packard Electric Co.
R. M. Robins, Sherbrooke, Que., Sherbrooke Power & Light Co.
Walter H. Reesor, Lindsay, Ont., Manager Light, Heat & Power Co.
Herbert Riddell, New York, "Illuminating Engineer."
Joseph Rogers, Toronto, Rogers Electric Co.

S

S. W. Smith, Montreal, Canadian Westinghouse Co.
H. S. Steele, Pittsburg, Pa., Pittsburg Transformer Co.
Edward F. Sise, Montreal, The Wire & Cable Co.
A. H. Skeene, Sudbury, Ont., Wahnapitæ Power Co.
R. J. Smith, Perth, Ont., Canadian Electric & Water Power Co.
R. M. Saxby, Whitby, Ont., Supt. Corporation Plant.
C. W. Schiedel, Waterloo, Ont., Manager Waterloo Elec. Light Co.
Arch. W. Smith, Toronto, "Engineering Journal."
R. A. Stinson, Montreal, Allis-Chalmers-Bullock.
B. F. Selby, Toronto, Canadian General Electric Co.
J. Sangster, Power Glen, Ont., Hamilton Cataract Power Co.
J. A. Shand, Toronto, Allis-Chalmers-Bullock Co.
H. F. Strickland, Toronto, Chief Electrical Inspector Can. Fire Underwriters Assn.
Elmer A. Sperry, New York, Electrical Engineer.
Herman F. Schædel, St. Catharines, Ont., Sunbeam Incandescent Lamp Co.
Alexander Storer, Toronto.
Thomas Stewart, Lindsay, Ont., Light, Heat & Power Co.
Charles B. Smith, Hamilton, Hamilton Anchor Co.

T

J. P. Thomson, Toronto, Eugene F. Phillips Elec. Works.
G. A. Thomson, New York, Adams-Bagnall Electric Co of Cleveland.

W

Ewart B. Walker, Toronto, Canadian General Electric Co.
George E. Waller, Hamilton, Hamilton & Grimsby Electric Ry.
H. W. Woodman, Hamilton, Woodman Bros.
A. A. Wright, M. P., Renfrew, Ont., President Electric Light & Power Co.
W. V. Warren, Montreal, Allis-Chalmers-Bullock.
John J. Warren, St. Catharines, Ont., Packard Electric Co.
W. Williams, Sarnia, Ont., Manager Gas & Electric Co.
J. J. Wright, Toronto, Toronto Electric Light Co.
W. H. Wiggs, Quebec, Mechanics Supply Co.
J. F. H. Wyse, Toronto, Wyse & Middlemist.
I. H. Wright, North Bay, Ont., North Bay Light, Heat & Power Co.
H. Webster, Norwich, Ont., Norwich Electric Light Co.
T. R. Waugh, St. Marys, Ont., Corporation Plant.
A. M. Wickens, Toronto, Chief Engineer Canadian Casualty & Boiler Insurance Co.
John Watts, Toronto, Canadian General Electric Co.
C. H. Wright, Ottawa, Canadian General Electric Co.

Y

T. S. Young, Toronto, "CANADIAN ELECTRICAL NEWS."

The President: Gentlemen, we are somewhat later in commencing the meeting than was expected. My idea is that we should run on schedule time the same as railways are run, and if there is any virtue in the debate and papers read here every man should be entitled to have it. There is a little opening ceremony I believe to be gone through with before we enter into the real actual work of the day, and I will now call on Mr. Cutler, the Mayor of Niagara Falls on the American side of the river, who will speak to you for a few moments. (Applause).

ADDRESSES OF WELCOME.

Mayor Cutler: Mr. President, Officers and Members of the Canadian Electrical Association, on behalf of the City of Niagara Falls and its citizens I welcome you within our gates. You certainly have paid us a very great compliment in coming here to hold this your sixteenth annual convention, and I can assure you that it will be fully appreciated by the Mayor and our citizens. We realize that you are members of a profession which has probably made more rapid strides in science during the last decade than any other, and we think it very fitting, and you did probably, that you should hold this convention here at the place you have aided so much in making more famous as the city of the most gigantic and most wonderful hydro-electrical development the world has ever witnessed. For this reason we extend to you a special welcome. Of course, we are glad at all times to welcome the delegates to almost any convention, but we realize that you are gentlemen possessed of intelligence and culture far in excess of those who usually meet; in fact, the occasions have been rare that we have ever had the privilege of welcoming gentlemen of your calibre and your attainments here. We feel that this is especially happy for us at this time when our locality is being assailed, so to speak, at a time when a senseless impression prevails throughout the continent, and the world I may say, regarding conditions here; and we feel that having come here and having gone away from here you will be able to do much in correcting this erroneous impression which prevails. In fact, we feel it stands you in hand to do so, as you are enumerated among the chief culprits through your operations in harnessing the Falls for generating and transmitting electricity—as, I say, you are enumerated among the principal culprits in detracting from the beauty of the Falls, and are charged by the cranks, the yellow journalists, and through misapprehension by many good people, as being in league to ruin the Falls and cause them to run dry, thereby exposing the bed of the river for utilization as railroad beds, roadways and the like of that. Now you can see for yourselves and you can learn that notwithstanding a large amount of water is being diverted for power purposes at the present time, still the volume going over the Falls is larger than ever, and if men of your trained minds and your acuteness will take the trouble to observe, as of course you will, you may from various view-points here obtain object lessons which will satisfy you that the Falls so far as their scenic beauty is concerned are not in any danger of defacement or material lessening, notwithstanding the fact that all power should be utilized by the various companies that now have grants either from the State of New York or from the Canadian Government. For instance, if when you were across the river down on a pier that has been erected there in connection with the coffer dam by the Electrical Development Company, while standing upon that pier and watching the water at a depth of 26 feet rushing past at a great velocity, and then if you size up in your mind that ten or twelve times the amount of water which is being delivered by the tunnel down here—whereby nearly 100,000 electrical horse power is being developed—if that were all taken from that point the river would not be lessened. Of course you engineers probably have a way of arriving at it by more accurate computations, but laymen like myself like to make comparisons of this kind. I think you will become convinced that if all the water planned to be taken from the river should be taken from the river to turn all the wheels to comply with all the grants, that the Falls would not be materially injured in their scenic beauty. It therefore devolves upon gentlemen like yourselves as you go back to your constituents, through them and through your trade journals, to rectify this erroneous impression which obtains. I do not know how the movement started, but we do know that every long haired man and every short haired woman in the country, every yellow journal and the busybodies, people who meddle with other people's business, assume that they have more to do with Niagara Falls than the families who have owned land along the river here for generations—these people who may come here once a year or once in five years. We people who li e here certainly have not only the commercial value at stake, but of course we feel that our place has been built up and made world famous through the wonderful scenery which the Falls possess, and we appreciate, as I want to reiterate, when gentlemen of your character come here that you can do much to straighten out this affair and at least rectify in the minds of thinking people the belief to which a good many well intended people have become converts, that the Falls are nearly run dry, when as a matter of fact there is more water going over now than ever before. You will have done us a very great service if you will interest yourselves and make it a point to disseminate the proper knowledge as to existing conditions here. Out of courtesy to Mayor Slater from our sister city across the river, and out of sympathy for you, I will say nothing further, only to assure you again of a most

cordial welcome and to wish for you that your time here may be most pleasantly and profitably spent not only for yourselves but for your association. (Applause).

The President: I have now much pleasure in calling upon Mayor Slater from the Canadian side of the river.

Mayor Slater: Mr. Chairman and Gentlemen, I am sure it is only proper and right that Niagara Falls on both sides of the river should welcome any visitors and all visitors interested in the development of electrical power in this country. Only a few short years ago, twelve or fifteen years, this city had a population of somewhere between 8,000 and 9,000, and now has 30,000. Our city on the Canadian side had 3,000 or 4,000 and we are now somewhere near 10,000. Of course, that is a great deal to be thankful for, and while it is very grand and very natural and has been in the past the place where bridal couples found it very comfortable to visit, still at the same time I think you will agree with me that the real comfort that has been conveyed to the world and to the countries in general through the development of electrical power at Niagara Falls will more than counterbalance any comfort or any happiness that the bridal couples might have enjoyed by visiting the Falls of Niagara. (Laughter). I quite agree with Mayor Cutler that it is high time these people got a little horse sense and were not carried away with the idea that Niagara Falls is being ruined because the brains of the twentieth century has been enabled to put to use that water that has been running to waste for so many years. We heard no kick coming from all over this country when they built the Welland canal or when they built the Erie canal or the Illinois and the Michigan canal, or when they are now talking of tapping Lake Erie and taking it down the Ohio river. Now, the Welland canal and the Erie canal and the canal taking the water to the Ohio river are actually diverting and destroying the waterway Nature prepared for us. Surely these long haired men and short haired women might pay some little attention to these other developments that are being talked about and not simply jump right onto the fountain head where all the electricity, in their imagination, is being generated. Now, gentlemen, I am glad that you are here from all parts of Canada and I am glad that there are some here from all parts of the United States, but I do think we in Canada—well, they need education on this side too—we in Canada have got a very wrong impression simply from the fact that we have paid so little attention to it and have not studied it long enough. If there is one thing more than another that these writers like to jump upon and talk about and abuse, it is something they know nothing about, that is what usually occurs. You can always tell a longer story about a thing you know nothing whatever about than about a thing you are very well posted on. That has been my experience and that has been the unfortunate fact among the legislators of our country and quite as much at Washington, and it is about time the electrical engineers and the people of this country should have the actual benefit of the country at heart and not an imaginary benefit that they think is going to be derived for all ages in order to make this a place where people can come for a holiday. Holidays are all right in their way, but if this twentieth century is going to say to the people of this country that we will go on, as Mr. Buck is quoted in the Toronto paper to-day, actually allowing power to run over those Falls that it would take 50,000,000 tons of coal a year to generate, surely, gentlemen, it does not require any long argument to convince men that have studied this question of the real benefit to the people of this century, that even the power that has already been developed here at Niagara Falls has been a great boon to both countries, and that being the case, it behooves every man that studies the question to go to his home and tell the people that the Falls are not being ruined in any way or in any form whatever. And they must bear in mind that there is other water that is being taken from these great lakes that will do just as much towards destroying the beauty of the Falls, only it is not taken at the Falls. The Welland canal and the Cataract Power Company take their power from the Falls just as the people here, and yet nobody says anything about them. They centre all their criticisms here because they can get to Niagara Falls cheaper than to any other place, and they do not see any place else and they do not know there is any other water development.

Your Chairman said he would be here for a little while. I am here to thank you for coming to Niagara Falls and I hope you will study the question fully, as I am sure you will, and when you go home tell these people they are laboring under a great mistake, that the Falls are not going to be injured in our time, nor probably in the time of our children, and that even if it is made a little less large in its volume going over, when we think of the tons and tons of coal, and the hours and hours of labor that that water saves, when we think of the blessings that it is carrying down to humanity, we can, if it is really necessary—although I do not believe it—we can sacrifice a little of the æsthetic for the comfort carried to the homes of thousands of people who are relieved of their burden, who would have to supply the power if it were not supplied by the Falls. I welcome you to the city of Niagara Falls on the Canadian side; I will do all I can to make your visit pleasant whenever it is in my power. If your Chairman will notify me I will be very glad to go with you and do anything I can. I want you to go back to your homes and tell the people that the big power companies here are not ruining the Falls, and try to convince them that it is not necessary to make any fool legislation, to go to work and try and destroy and take away from these people that have spent their money here to develop this power, to take away their right to use it as it was intended when the privilege was originally granted to them. (Applause.)

The President: Messieurs the Mayors of Niagara Falls on the American side and on the Canadian side, on behalf of the Canadian Electrical Association I must return warm and hearty thanks to you for the kindly welcome which you have extended to us here today. We meet under rather unique circumstances. This is the first time in the history of the Association when we have had the pleasure and the honor of meeting on American soil, and it is the first time when we have had twin Mayors, if I may use the expression, to deliver us a welcome address. We heartily appreciate this and we hope we may enjoy ourselves and they may enjoy themselves during the short time they are with us, and that we may have a meeting that will be productive of much good. I am exceedingly well pleased with the practical addresses which these gentlemen have made. I am delighted to know they are not as much frightened as some people seem to be with reference to the want of power which they have here at Niagara Falls. It is true there may be a large number of long haired men and short haired women on both sides of the line that are somewhat excited over this thing, but I think they can fairly well possess their souls in patience. I do not think we are going to be deprived in the near future of the scenic effect which these waters have at Niagara Falls. You know we have had a Hydro-Electric Commission appointed in the Province of Ontario and they have been taking a great deal of pains to come to some agreement with reference to what amount of power we have here. We have an International Commission who are working on the same thing, and I think they will be productive of much good and will be instrumental in driving away that mist which appears to come before the eyes of some people. You know Professor Fessenden, who is, by the way, a Canadian-American electrical engineer now from the city of Washington, has gone into this thing along with some others in a most extensive manner and here are the results which he has given out. He says that in the water power here we have a capacity for producing no less than 6,000,000 horse power, and when that is turned into dollars and cents it represents a capitalization of no less than $2,000,000,000. Now it is hard for us to take in what

6,000,000 h. p. means. Will you allow me to give you, Messrs. Mayors and gentlemen, one illustration of what it means? If you take all the power that is generated by all the boilers and all the engines in Great Britain and Ireland it will not reach to the amount that we have here at our disposal. Now, it will be three or four years before we exhaust the power that is here, in my opinion.

Mayor Cutler: How many?

The President: Three or four at least. (Laughter). So that I think our friends can safely rest assured that there is no danger to the scenic appearance of the Falls in the immediate future. Again allow me on behalf of the people here assembled to thank you most heartily for the warm manner in which you have welcomed us here and I trust and believe we will have a most enjoyable and instructive meeting at this first meeting on American shores. (Applause).

The President: The next on the program is the President's address. From past experience I have learned that we have not been in the habit of meeting promptly on time. I was fearful that the same thing would happen here, that it would be another instance of history repeating itself. Consequently, I have made my address as short as I thought it was advisable to make it, and without any further remarks I shall proceed to read it to you. But before I do so I wish to make this further remark. I am glad to know that this is to be a business convention. We are here to gain information which will be of service to us in after life. Let us attend to business while we are at business, and when we are at play, why let us play. I know that "all work and no play makes Jack a dull boy", but if it is all play it makes Jack a very poor boy. Now, I do not suppose that there are going to be many millionaires develop from the ranks of the Canadian Electrical Association here, but still we want to be able to earn a certain amount of money at least and the only way we can do that is to be thoroughly posted on all the branches of our profession. I believe we will get a large amount of information here, and I wish now to make just this remark that every paper shall be called for when the time comes for it. If you are here to hear that paper, well and good. If you are not, you will lose that much of valuable information.

PRESIDENT'S ADDRESS.

To the Members of the Canadian Electrical Association:

Gentlemen,—It is with more than ordinary pleasure that I welcome the members of the Canadian Electrical Association at this their Sixteenth Annual Convention to this historical portion of the American Republic. To-day all eyes are turned to this busy electrical centre where so much is being done by the latest and most improved methods to not only generate electricity on a gigantic scale but also to distribute it in the most economical manner to long distances, to be there used in bettering the conditions of our great manufacturing industries as well as adding to our social and domestic comforts.

Since our last meeting here remarkable progress has been made by the people of Niagara Falls, in electrical growth and commercial improvement generally, and we confidently expect that at this convention we will all receive much valuable information and of such a practical nature as will be of material service to us in the future.

I must congratulate our members on the continued growth and prosperity of our association and I have no doubt you will all agree with me when I state that one of the most potent factors which has assisted in leading up to this result has been the intelligent manner in which the Question Box has been handled by our respected ex-president, Mr. A. A. Dion, and as time goes on and when these important questions and comprehensive answers shall have been compiled and preserved, a most valuable electrical lexicon will have been formed for future reference which cannot fail to be most useful to every person who is engaged in electrical enterprises.

It is by no means undesirable that I should draw your attention to the valuable work the Dominion Government has performed in sending a number of able and competent gentlemen to Europe to investigate the best methods practised there for smelting certain grades of ores by electricity. On the return of these gentlemen from prosecuting their investigation a sufficient sum of money was placed at their disposal by the Government to establish one of these experimental smelting works at Sault St. Marie and the results of these experiments have surpassed our most sanguine expectations. The following are the results as reported by Dr. Haanel himself.

1st. Magnetite can be as economically smelted by the electro-thermic process as Hematite.

2nd. Ores of high sulphur content not containing manganese can be made into pig iron containing only a few thousandths of a per cent. of sulphur.

3rd. The silicon content can be varied as required for the class of pig to be produced.

4th. Charcoal which can be cheaply produced from mill refuse or wood, which could not be otherwise utilized, can be substituted for coke as a reducing agent without being briquetted with the ore.

5th. A ferro-nickel pig can be produced, practically free from sulphur and of fine quality, from wasted nickeliferous pyrrhotite.

6th. The experiment made with titaniferous iron ore containing 17.28% of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5% titanic acid can be successfully treated by the electric process.

I need scarcely tell you that these are results of vast commernial value to the mine owners of the Dominion.

It is also desirable that we should bear in mind the action that the Dominion Government has taken in introducing a bill for the purpose of controlling the exportation of electric current to the United States.

No action other than introducing the bill has been taken and further proceedings have been stayed pending a conference with the Ontario Government with the view of having the two governments act in harmony in whatever action they may deem it advisable to take. Until some real understanding has been arrived at, it will be impossible for us to discuss this matter intelligently, not knowing what the bill may provide for when it is finally completed and passed the House of Commons.

I wish also to draw your attention to the radical departure which the Ontario Government has taken in appointing what is called a "Hydro Electric Power Commission" which consists of three members, and whose duties it will be to carry out the Government's policy of supplying municipalities with cheap electrical power by means of assisting these municipalities interested in acquiring and developing water powers for the purpose of generating electricity for the use of these municipalities for light, heat and power purposes.

We are undoubtedly entering upon an era of wonderful electrical developement in which the Dominion of Canada, with her vast number of magnificent water powers scattered as they are over such a wide extent of territory, will, when developed, form a most important factor. Among the rapid steps forward is the probability of the Ontario Government running the trains on the Temiskaming Railway by electricity, which will be by no means the least noteworthy in this onward progressive movement.

It is pleasant to note the commerical activity that prevails in every branch of our calling, and we can confidently look forward with unbounded hope in the future, believing that in electrical enterprises as indeed in almost all others the Twentieth Century will be Canada's Century, so far as material progress and development are concerned. I shall merely remark in conclusion that we will during this session more than at any other adhere closely to our previous wise decision to devote an increasingly large share of our time to the reading of papers and the intelligent discussion of them rather than devoting so much of our valuable time to the social side of life.

A. A. WRIGHT, M. P.,
President.

The President: Mr. W. H. Wiggs, of Quebec, has something to say to us for a moment or two.

Mr. W. H. Wiggs: Mr. Chairman and Gentlemen, doubtless a number of you remember the convention which was held in the City of Quebec some five or six years ago, I believe, when you all had a little taste of Quebec's hospitality. I have no doubt you learned then that Quebecers differ a little from the rest of Canadians in that both our hands, right and left, are connected to our hearts, and we offered you then as I said a little taste of our hospitality. Doubtless some of you may not be aware that in 1908 we intend celebrating the founding of Canada. On the 3rd of July, 1608, the foundation of Canada was laid on that impregnable rock, the City of Quebec. As a member of the Executive Committee appointed in Quebec to take charge of this celebration, I thought while I was here as a member of this Association I would like to bring this matter before your Executive Committee and have them take it up seriously so that during 1908 you will come and help us celebrate this unique epoch in Canadian history. One of our writers has said

> " Breathes there a man with soul so dead
> Who never to himself has said
> This is my own, my native land,"

and I believe we as Canadians have a great future before us. As you said in your address, Mr. President, Canada has yet to develop, and if you will come and join with us in 1908 in Quebec I think we will then

start a new epoch in the fourth century of Canada's history. One of our Canadian writers has said:

"O, Canada terre de nos aiyeux
Ton front est ceint
Ton histoire glorieux,"

and we as young Canadians want to make a glorious history for Canada. We invite you heartily to come down to Quebec and make that your home during the few days you have your convention in the year 1908. I am sorry I have had to trespass on your program, but as I have to get away at four o'clock I thought I would take the liberty of introducing this matter just here.

The President: I am sure we are all pleased with the very kind invitation which has been extended to us. It certainly would be a most appropriate place for us to visit and an appropriate time for us to visit there also. This is a matter that will come before the convention in due course, and I hope the answer which will be given to you will be satisfactory. We will now call on the Secretary-Treasurer to read his report.

SECRETARY-TREASURER'S REPORT.

All matters connected with last convention were finally disposed of at an Executive meeting held in Toronto on November 11th, 1905.

Mr. K. B. Thornton, Ex-President, resigned from the Committee owing to his removal to New York.

Mr. James Robertson, of the Montreal Light, Heat & Power Company, was appointed as his successor.

Mr. R. G. Black was appointed Chairman of the Committee for the Advancement of the Interests of the Association.

The following gentlemen were appointed a Committee to make the necessary local arrangements for this convention: Messrs. R. B. Hamilton, St. Catharines (Chairman), J. A. Kammerer, J. W. Campbell, Toronto, P. J. Myler, Hamilton, with power to add to their number.

Messrs. R. G. Black and James Robertson were appointed a Committee on Papers.

Mr. W. Williams was elected a member of the Committee on Legislation for Ontario.

Mr. T. S. Young was appointed assistant to the Secretary without extra expense to the Association.

An invitation was received from the Secretary of the Institution of Electrical Engineers of Great Britain to participate in the International Electrical Congress which met in London in June. The Secretary was directed to acknowledge the same, and to learn if any of our members would be able to attend, also to make enquiry as to what action would be taken by the American Institute of Electrical Engineers and the National Electric Light Association, and on what terms members of this Association might accompany delegates from these Societies. The result of this enquiry showed that the American Societies were unable to make any special transportation arrangements for their members. This Association was represented at the Congress by Professor Herdt of McGill University, Montreal.

An invitation was also extended to the officers of this Association by the National Electric Light Association of the United States to attend the Annual Convention of that Society at Atlantic City.

On February 28th meetings of the Local and Executive Committees were held in Toronto, when the dates were chosen for this convention, headquarters to be at the Clifton House. It is a great disappointment to the Committee that the hotel could not be put in operation early enough to provide accommodation for the delegates to this meeting, and it has been necessary at the last moment to change the headquarters to the International Hotel, Niagara Falls, N.Y.

On motion of Messrs. Hunt and B'ack the Executive voted $200.00 for convention expenses.

It was decided that only members in good standing who shall have paid their fees for the incoming year should receive badges admitting them to the sessions of the convention, and that the names of all persons who do not remit their fees to the Secretary within six months after this convention shall be dropped from the membership roll.

At date of my last report the membership list showed 285 Active and 126 Associate members, total 411. The present record is 238 Active members and 152 Associate members, total 390. The reclassification of Active and Associate members during the year accounts for the apparent reduction in the number of the former as compared with last report. By reason of the transfer the list of Associate members shows a corresponding gain.

I regret to have to record the death since last convention of one of our members, Mr. H. N. Dignam, of Bowmanville.

I beg to present the following audited statement showing in detail the Receipts and Disbursements for the year:

RECEIPTS.

Cash on hand June 1st, 1905	$ 19 02	
Cash in Bank June 1st, 1905	975 02	
167 Active Fees at $3.00	501 00	
2 Associate Fees at $2.00	4 00	
63 Associate Fees at $3.00	189 00	
2 Student's Fees at $1.00	2 00	
		$1690 04

DISBURSEMENTS.

Postage (including Postage on Question Box and Proceedings)	62 87	
Stationery	3 15	
Box for holding Association Documents	1 50	
Ribbon for 375 Badges	4 25	
Embossing Badges in Gold	18 75	
Telegrams	1 55	
Exchange on Cheques	5 90	
Express Charges	2 60	
Expenses on account of Question Box, per A. A. Dion	103 20	
Stenographer for Convention	50 00	
Grant to Secretary	150 00	
Printing	138 00	
Engravings for illustrating Papers	18 35	
Amount paid Janitor in connection with Montreal Convention	10 00	
Cash on Hand June 1st, 1906	13 45	
Cash in Bank June 1st, 1906 (less Cheque of May 28th outstanding, $25.00)	1106 47	
		$1690 04

With the presentation of this my Fifteenth Annual Report, I beg respectfully to tender my resignation as Secretary-Treasurer of the Association. This step has been rendered necessary by the demands of my business. I have watched with pleasure the growth of the Association from a membership of 25 to a membership of 390. Its position is now assured, and under the guidance of the many bright minds who have its welfare at heart, it will certainly go on to greater accomplishments in the future, keeping step with the wonderful developments of the science it represents.

I cannot conclude without expressing my appreciation of the uniform courtesy and kindness of the members towards me during the many years that I have occupied this position.

C. H. MORTIMER,
Secretary-Treasurer.

TORONTO, June 18th, 1906.

I have this day audited the accounts of the Canadian Electrical Association from the 1st of June, 1905, to the 1st of June, 1906, and have found same correct.

Very truly yours,
R. T. MACKEEN.

The President: I am sure that we all feel a certain amount of regret to think that our worthy Secretary-Treasurer is going to tender his resignation; still we are all pleased to know the cause, that he is making so much money in other directions that he cannot afford to lag behind with us.

Mr. A. A. Dion: I have much pleasure in moving the adoption of the report. I would like to take the liberty to ask again what the amount of cash in hand is.

The Secretary: $1106.47.

Mr. Dion: Then I have still more pleasure in moving the adoption of that report.

Mr. Reesor: I second the motion.

Motion carried.

The President: We shall now call on Mr. Converse for his paper.

Mr. Converse's paper will be found on another page.

The President: Gentlemen, you have heard this able paper so nicely illustrated. It will be for you to discuss it in any manner that you see fit.

Mr. R. G. Black: Mr. Chairman and Gentlemen, I think you will all agree with me that this is a very interesting and instructive paper on a very interesting subject. As you all know, three large power companies started out with practically the same problem, the Ontario Power Company, the Canadian Niagara Power Company and the Electrical Development Company. The Canadian Niagara Power Company started in with the experience which they learned from ten years' operation of the power houses on the American side, so that they tackled the problem with definite experience, and a definite problem they were going to undertake, the construction on the Canadian side being very similar to what they had tried and found to work very nicely in their previous plant. The Electrical Development Company and the Ontario Power Company had the benefit of this experience in a secondary way. They also have the benefit of the experience of all other plants, and were not tied down to any definite line of procedure. It is very interesting to note the different ideas which seem to exist in the minds of different engineers who had this work in charge. This paper has

served as an introduction to the opportunity which we will have to view the plant which has been so ably described, and when we see the actual machinery and the gigantic plant which the Ontario Power Company have we will fully appreciate the difficulties which these engineers had to encounter and overcome, and we will see what a splendid job they have made of it. In comparing the engineering which has been used in this plant with some of the other power plants, there is a marked difference. If you refer to page four of the printed paper you will see in the cut No. 9 that the switches are separated, each group of switches having considerable space between them and the other switches. If you will also refer to page 5, Fig. 15, you will also find that the control pillars for operating these various switches are also separated, considerable space being given to switchboard apparatus. It you will refer to the diagram Fig. 19, page 7, you will find there are a great many switches used, there being seven sets of low tension, that is 12,000 volts, switches used with each generator. So that a great deal of attention has been given to the switches. The construction is considerably different from the construction that we are most familiar with in Canada. We are quite familiar with the regular straight-line switchboard with panels all close together, arranged on marble or slate slabs. This construction is certainly very neat in appearance and from an operating point of view I would say it is exceptionally well laid out, and there is very little danger of the operator making a mistake. If you will refer to the transformers on page 4, Fig. 10, and the bus bars, you will find the bus bars and transformers are considerably closer together than they are in some of the other plants. In this connection I would like to ask Mr. Converse if he considers there is more danger from the switch apparatus than from the transformer apparatus, that is, which is most likely to fail and cause trouble? One set of engineers seem to have laid great stress on having plenty of room for switches and switching devices. Another set of engineers have put their switches all very close together, their panel boards being in a continuous wall and their switches being adjacent to each other, which is distinctly different from this type where not only the switches are separated but also the control board being separated. On the other hand, engineers of the Ontario Power Company have grouped their transformers, whereas the engineers of other power companies have separated them, putting each transformer in a separate cell by itself. It seems to me it is a very interesting point brought up in the engineer's mind and I repeat the question again in asking Mr. Converse which he thinks would be the most likely to give trouble. Another point which I would like to refer to is the headworks. I think Mr. Converse said that they arranged for an extra amount of water to come into the forebay in the hope that there would be a return wave which would carry the ice over the overflow wall. I would like to ask Mr. Converse if any experiments have been made on this, and how successful that scheme is. I should also like to ask him in reference to the line, what sag they allow in the 550 foot span. Referring to the line again, there is another difference which comes up between the engineers of this company and of another company who had a similar problem to tackle. Two of the companies at least have used steel towers and have used long spans, one company using aluminum, another company using copper. If Mr. Converse would be good enough to give us information on these points it would be interesting.

Mr. V. G. Converse: I will endeavor to answer Mr. Black's questions. The first one I believe was the segregation of the switches.

Mr. Black: The relative space given to the switches as compared with the transformers in your plant, as compared with the Electrical Development Company lay-out.

Mr. Converse: I am not familiar with the plans of the Electrical Development Company. Our arrangement is a unit one and the transformers were the controlling features in determining the width of a unit space in a building. The triangular grouping of transformers gives the most economical arrangement we could make. If they had been placed side by side the complete building would have been required to be some 200 feet longer. The width of the unit space is 22 feet, which allows the separation between the groups of switches that is noted in the low voltage switch room. Barrier walls separate each group of transformers, and different classes of apparatus which might give trouble one to the other have been placed in separate rooms, but we have not seen fit to build walls between like apparatus of a unit. The transformer cases are of a ⅝ inch steel and are so strongly constructed that they will stand 150 pounds internal pressure with all fittings. An 8 inch pipe extends from the top of each case to a sewer. From experiments we found that all the energy which can be liberated within a transformer case can be relieved through the 8 inch outlet pipe without exceeding the working preesure of the case.

Mr. Black: Where does that overflow pipe go to?

Mr. Converse: A special iron sewer extending underneath the building and with a manhole on the outside for a relief.

Mr. Black: Would it eventually go into the river?

Mr. Converse: Yes, by the way of the main spillway. The next question was the cross-current in the forebay. The idea there was to take in a considerably greater amount of water than was required for the power development. The excess water flowing over the submerged wall sets up a cross current which tends to carry any ice which may have come into the forebay over the wall and into the river. There are two depressions in the wall adjacent to the screen house, one being 2 feet and the other 4 feet lower than the main part of the wall. These depressions cause a final strong cross current in front of the screen house. The only test has been the practical one during the past winter when we had not the slightest trouble with ice.

Mr. Black: That cross current will take out the slush ice as well as the surface ice?

Mr. Converse: We did not have any trouble with it last winter. The last winter cannot be considered as a severe test, as it was not a particularly cold one. However, there was a great deal of ice came down at times, in fact I think there were a few times during the season when the ice conditions were nearly as severe as they ever are. One time, I believe on the 4th of March, the lower river rose fifteen feet within a few hours, due to the flow of ice. What was the next question.

Mr. Black: What sag do you allow for your 550 foot line span?

Mr. Converse: The sag at maximum temperature is 16 feet for the 550 foot span.

Mr. R. T. MacKeen: I have listened to this paper with a great deal of interest and pleasure. I notice on page 8 the statement "Horn gap lightning arresters of generous proportions and with graded gap resistances are located in the rear of the station." I would like to ask Mr. Converse what he means by graded gaps there, and also what kind of resistance he uses, and in connection with resistance I would like to know the maximum discharge current.

Mr. Converse: The arrester is of our own type and construction. The space in the rear of the station is filled with poles carrying lightning arresters. The horns and resistances of but one arrester are on a pole. The horns are about 6 feet long of ¾ inch brass and are mounted on caps, cemented to line insulators. By the adjustment of the horns in the caps we can get any desired gap. There are three sets of horns for each line wire.

Mr. MacKeen: Connected in series?

Mr. Converse: No, they all connect to the ground. The first one has a carborundum resistance composed of rods three inches in diameter and two feet long; six

of these rods in series give a resistance of about 10,000 ohms. This resistance will allow of the passage of from 3 to 4 amperes of current. The gap for this arrester will be set for a voltage of about 45,000, the normal voltage to ground being 36,000. We hope that this arrester will take care of the largest part of the lightning discharges. The resistance for the second arrester is causing us a great deal of trouble. We have been unable up to the present time to decide just what it shall be. We hope to use a water resistance, the water being contained in barrels. The resistance which we would like to obtain is one of about 2,000 ohms, which will allow considerably more current to flow through it than the resistance of the first arrester. The setting of the horn gaps should be for about 65,000 volts. The horns on the third arrester are in series with a small fuse about 15 feet long held on the side of the pole and connected to ground. The setting of this arrester will be for about 100,000 volts. The greater part of the lightning discharges should go over the first arrester with the carborundum rods. The remainder is expected to select the other resistance paths according to the quantity of the discharge and the setting of the horns. A charge over the arrester with the fuse will probably shut us down but it is better to be shut down in this manner than to be permanently disabled.

Mr. MacKeen: What factor of safety do you estimate you have in the station?

Mr. Converse: Insulation?

Mr. MacKeen: Yes.

Mr. Converse: We test all our high voltage station wiring with 150,000 volts to ground. Choke coils have been tested with 200,000 volts between bushings.

Mr. MacKeen: My experience with high frequency discharges has been that series resistances are very objectionable; there appears to be a very high ohmic resistance and the voltage builds up around the resistance, whereas with low frequency discharges the difference is not so apparent.

Mr. Converse: That is true; we tried to make the path for the lightning as easy as possible by making the resistances as well as the leads to ground with liberal surfaces. The ideal arrester is one which gives an absolute ground to the circuit. I do not know how it is to be obtained except in some such way as described. We consider the arresters to be still in the experimental stage and we will know more about them after a season's use.

Mr. A. A. Dion: Plants like this of such importance and magnitude have naturally a great deal of engineering talent expended upon them and a great deal of attention given to details which become of great importance in a plant of that character, and this results in certain features which might be applied with advantage to smaller plants. There are few of us who have or will have anything to do with plants of this magnitude, but we may from the description of these plants find features which we could apply with advantage to the plants with which we have to do. One thing that struck me as worthy of commendation in the design of this plant was the symmetry in the arrangement of the apparatus from the generators to last control board, a symmetry which would give the controlling operator, I should think, a great deal of facility in operation, preventing mistakes and that sort of thing. The arrangement seems to be such that, standing on the gallery, the operator can form a mental diagram of the whole plant; everything running along definite lines so that he cannot possibly get things mixed up. I would like to say that I specially admire the segregation of the switchboard control units. It seems to me it has been a fault in the past in most plants that control apparatus has been crowded into a small space. While we are willing to allow all necessary space for generators and auxiliary apparatus, when it came to the switchboard and control apparatus we seemed to have very little space left and it was to my mind crowded too much. Now, if the manufacturer was asked to design a switchboard for a plant that is going to transmit at 60,000 volts, he would pay a great deal of attention to it and design it in a special manner to meet the conditions, but when dealing with lower voltages, such as most of us deal with, say from 2,000 to 10,000, the same care does not appear to be exercised, and I believe manufacturers crowd their switchboard apparatus too much. I have seen in plants of large capacity switchboards installed in such a way that the only thing that saved them was absolute absence from trouble, because if trouble arose at all it seemed to me it was bound to be very serious and very destructive. Now, one thing I have observed about the Niagara plants generally and one I think that might be of value in much smaller plants, is the covering of the inner racks or screens with a building of some sort, completely closed, and admitting the water to the inner forebay through submerged arches. One of the objects of the submerged arches I suppose is to prevent the drawing in of floating ice, but there is another advantage in it which is perhaps not generally recognized, and that is that you prevent extreme temperatures from reaching the inner screens. Take it in winter when the water is just about 32°, just about freezing, and the air is about 20° below zero, if a strong wind is blowing against the open screens you will get such very low temperatures in that part of the screens that is exposed to the air, that you are bound to lower the temperature of the rest of the screen, because iron is a very good conductor. This will result in ice forming below and blocking the screens. I do not pretend to be the inventor of this theory, but I believe it is correct, that much of the freezing is due to the lowering of temperature of the iron screen, due to the upper part being exposed to the cold blast of air. Now, the housing of the upper part of the rack stops the currents of air, and in still air the temperature will never be so low, and the freezing of the water will be retarded, if not largely prevented. I think this is a very valuable feature in station design.

Mr. Converse: There was one question asked by Mr. Black which I did not fully answer—I do not know that I even touched upon it. It was the reason for allowing so little distance between the high tension wires. This is the very point on which we pride ourselves that we have so much clearance between the high tension wires. The high tension busses have 7 feet between them. At the closest point in the wiring which is over the transformers there is three feet but the voltage between wires here is only 36,000. As stated, all our high voltage wiring is tested to ground for 150,000 volts. The wire itself is insulated with varnished cambric which stands a test of 120,000 volts. The insulation is not intended to admit of the handling of the wires, but if the attendant did get against them he has a possible chance of getting away again without serious injury. The insulation also would tend to prevent short circuits by the dropping of switch handles or anything else across the wires. We have not placed barriers between our high tension busses and wires because in our opinion such barriers either weaken the insulation or lead to a very expensive construction. Consequently we have allowed ample distance and only put the insulation around the wires for emergencies.

The President: As Mr. Dion has said, although every power development in the country is not on such an extensive scale as the ones here at Niagara Falls, still the ideas here are potent and can be used in other plants and found useful. Is there any one here that has anything to ask?

Mr. J. W. Campbell: In matters of this kind there is great hesitancy on the part of many of our engineers. We have in the Canadian Electrical Association a goodly number of engineers well qualified to discuss matters of this kind in every detail, but unfortunately they have not all been favored with association with large concerns as we are discussing to-day, and as that presented by Mr. Converse. Apparently as no one else seems to wish to discuss the matter any further, and as the paper has been a very interesting one, which I feel every one will be concerned in and will

read up carefully and glean what points they can from. I have very much pleasure in moving a hearty vote of thanks to Mr. Converse for his very intelligent and instructive paper.

The motion was seconded and carried amid applause, and presented to Mr. Converse by the President.

The President: Now the time has arrived for us to take up the Question Box, which is one of the most important features before us, and I will call on Mr. Dion to introduce it.

Mr. Dion: Mr. Chairman, you will notice that the Question Box is not printed in the usual book form, but rather in the shape of a temporary booklet not intended for permanency. I was prevented by circumstances which I could not control from sending out the questions as early as I would have desired. The result was that answers did not reach me until almost too late to publish the book in time for this meeting unless I left out many valuable contributions which reached me at the last moment, and as others had promised to contribute and had not done so I judged it would be better to make a departure this year from the customs of previous years and to come to the convention with a temporary publication which could be taken up and discussed further, and when it had been added to at this convention by discussion and other answers to be contributed at this meeting, it could then be published in book form and be sent to the members in a more complete and useful condition. You will notice that some of the questions are pretty well answered, some questions have received several answers, other questions of importance have not been sufficiently answered, and the member who asked the question would probably feel he is not getting the information to which he is entitled; and some questions are not answered at all. In bringing the Question Box before you in this way you have an opportunity to add to it by giving additional answers to some of the questions, or giving answers to some that have not been answered. If there is any member here that is interested in any one or more questions, who would like to get more light upon it, I would be pleased if you would mention the question, and probably some of the members here can supply information. At a later stage of this convention the Question Box comes up again and I propose to take out these questions that have not been answered at all and ask for answers. After the convention is over if there are still questions unanswered, I will select men who in my mind are well qualified to answer them, and ask them for answers. I think the man who sends a question to the Question Box is entitled to an answer. I would like to say a word with regard to the rather extravagant praise which thePre sident gave me in connection with this Question Box.

The President: No, that is the proper word.

Mr. Dion: I have said before that it was a labor of love, but I would like to say the labor has been made very light by others who were not mentioned. I have received very valuable assistance from members of this Association who not only answered questions but went out of their way to get answers from those who were qualified to give proper answers. I would like to mention in particular Mr. R. G. Black. (Applause). He deserves the thanks of myself and the Association for the assistance he has given.

The President: There are some questions that are still unanswered. If there is anyone who wishes to answer any of these questions I suppose it would be in order for them to do so now. We have got a large amount of talent here. What is the first question, Mr. Dion, that is not answered?

Mr. Dion: No. 9 is not answered. "Has the charging of electric automobiles proved a success from the financial standpoint, in Canadian cities?"

The President: Is there anyone here that has had any experience in that? We would hardly expect small-station men to have had any such experience.

Mr. Dion: What do you do in Toronto?

Mr. MacKeen: My impression is that the question as far as Toronto is concerned can be answered very easily with the statement that we have very few electric automobiles in the city. However, I think there is no question that a very profitable business could be worked up providing the electric automobile business was what it might be.

Mr. Dion: No. 14 is a very peculiar question; I do not expect to get many answers to that.

The President: What is the general answer to that?

A Voice: No.

The President: So far as I am concerned I can say "Nay"; perhaps there are others who would say "Yea". We would be glad to hear from both sides.

Mr. Dion: Question 23 has been answered by Mr. Wyse, but this is a very practical question and I would like personally to get a little more information. The question is "Are elaborate records of lines where a card is filed for every pole, showing the position, size and name of every wire, advisable? Is the expense of keeping these accurately aud up-to-date warranted by the advantages, if any?"

The President: Is there anyone else who has had experience in that line? (No answer).

Mr. Dion: Questions 30 and 31 are the next; they have reference to steam plants. I think perhaps that is far enough for us to go to-day.

The convention adjourned at 4.45 till 8 o'clock p.m.

EVENING SESSION.

The convention resumed at 8 p.m.

Mr. F. O. Blackwell read a paper describing the power plant of the Electrical Development Company. This paper is printed elsewhere.

DISCUSSION.

A Delegate: Is there any reason for the concrete arches in the wheel-pit?

Mr. Blackwell: They were intended to prevent closing of the sides of the wheel pit, though as a matter of fact after the first movement which took place while it was being sunk, it has not closed at all. Of course, the arches give a very rigid construction and there is less vibration than with steel beams.

Mr. Dion: I do not quite understand from the drawing the mechanism of the gates.

Mr. Blackwell: The gates are of cylinder type. The upper gate moves from above and the lower from below.

Mr. Dion: I would also like to ask about the division of the line into sections. You stated that the line was divided into four sections and any section could be cut out and the rest would operate. How is this done?

Mr. Blackwell: What I meant was that the part of any one of the circuits between the section houses could be cut out and the remainder of the circuit on both sides of it would still be in operation.

Mr. Converse: Is there an automatic arrangement to cut out a short circuited feeder without interfering with the other circuits?

Mr. Blackwell: Yes. The idea was that with three or more circuits in parallel a short-circuit in any one would cause about twice the current to flow in that circuit that flowed in the other two. There would therefore always be more current in the short-circuited line than there would be in the neighboring lines. A differential relay will hold in the circuit breakers on lines which have the least current and open the circuit breakers on the line which has the most current. The difficulty with reverse current relays is that they open all lines in parallel, but by this arrangement you open only the one line, as the relay can only throw in one direction and all three circuit breakers cannot go at once.

Mr. C. H. Wright: On page 24 of the paper as printed, at the last paragraph, it states that you adopted the bench board system. This afternoon we had some little discussion as to the relative merits of the bench board system and the instrument column system.

In Mr. Buck's paper I believe the standard panel system has been adopted. I am sure this Association will be glad to have the reasons why the Electrical Development Company adopted the bench board system in preference to the two others. I notice on page 25, the third last paragraph at the left, that the high tension wires are all totally enclosed. Mr. Converse in discussing his paper this afternoon said that they considered that this total enclosing brought the ground too near the high tension wires. I presume the reason for the adoption of the total enclosure by the Electrical Development Company was to avoid arc spreading. Perhaps you might give us some further light on that. Further on on that page it is stated that "A large portion of the power is delivered to synchronous apparatus, the Toronto Street Railway employing rotary converters, and the Lighting Company synchronous motor-generator sets." Apparently all the apparatus is synchronous, that is to say, it is in unstable equilibrium. Has the matter been discussed of introducing some lagging apparatus such as induction motors, or do you consider that the entire distribution by means of synchronous apparatus will be satisfactory?

Mr. Blackwell: Regarding the bench board system, of course there is room for a difference of opinion, but the objection to the bench board as generally constructed with the instruments separate and at a distance from the bench board is that a man is very apt to get confused and perhaps throw the wrong switch. The bench board is more campact and can be operated more quickly than with a lot of switches on different panels distributed over a wide area. I believe the Electrical Development Company switch board avoids these difficulties. We have a bench board which is reasonably compact, so that a man can without moving from his position reach all the switches. At the same time, we have the instruments and controlling switches located with relation to each other and connected by dummy busses so that the operator can not readily make a mistake. As to the use of barriers between high tension wires, I do not look at them as a preventative of grounding, but as a safeguard against the possibility of an arc starting at one wire and sweeping through the entire station. I have seen an arc blow forty or fifty feet down a station and short-circuit everything in sight.

Mr. C. H. Wright: That same result would not be accomplished by more air space?

Mr. Blackwell: You would have to have a prohibitive space between every two wires and then you would not be absolutely safe. It is not that the arc jumps such a distance, but if it once starts a very little draft will carry it a long distance.

Mr. C. H. Wright: Will all the load at Toronto be synchronous machinery?

Mr. Blackwell: As to synchronons machinery, the intention is not to use all synchronous apparatus but only to have enough to be able to maintain a good power factor for the system. Whenever synchronous motors can be used I would give them the preference because there are always a lot of motors that will necessarily be induction because they are too small to be synchronous. If we could get a plant with half synchronous and half induction motor load we would have an ideal arrangement.

Mr. C. H. Wright: If synchronous apparatus were used exclusively would the system be sufficiently stable?

Mr. Blackwell: I do not think there is any trouble from "hunting" with the synchronous motors that have recently been designed. I would not hesitate to employ synchronous apparatus exclusively in a plant with modern apparatus equipped with efficient anti-hunting devices.

Mr. G. B. Berg, Hamilton: I should like to know how close to the sine wave is the wave of E. M. F., how much it deviates from the true sine wave?

Mr. Blackwell: The wave is almost a perfect sine wave. If I remember correctly I specified five per cent. variation, but it is very considerably closer than that. I think it came down to 1½ or 2 per cent. Laying it out as a panel wave you could say it was a perfect sine wave to look at it.

Mr. D. P. Burke, Ottawa: Is the distribution going to be at 25 cycles in Toronto, or 60 cycles with frequency changers?

Mr. Blackwell: The distribution for power purposes as far as possible would naturally be 25 cycles, but the alternating lighting system is 60 cycles now and frequency changers will be used for all the existing load.

Mr. A. B. Lambe: In Mr. Converse's paper he described the transformer system as consisting of three transformers pretty well permanently tied together and the three in the one pit. As opposed to that the Electrical Development Company have a transformer on each side and each in its own pit. It would be interesting to hear the gentleman on the reasons for his choice between the two.

The President: I am afraid that would be introducing a debate we have hardly time for here.

Mr. C. B. Hunt, London: I would like to move a very hearty vote of thanks to Mr. Blackwell for the paper he has presented to us. It has been very interesting to me and I presume to all of us. Mr. Converse' paper was equally good this afternoon, but this is valuable because it gives us particulars of a different system.

Mr. B. F. Reesor, Lindsay: I have much pleasure in seconding Mr. Hunt's motion. (Carried amid applause.)

The President: I have much pleasure in presenting to you this hearty vote of thanks which has been tendered to you in this magnificent manner.

Mr. H. W. Buck then read a paper on "The Electrical Plant of the Canadian Niagara Power Company", which will be found elsewhere.

A Delegate: How does that insulator compare in cost with glass?

Mr. H. W. Buck: The cost is considerably higher, but it seems to be justified, the maintenance on the insulator being less. The cost roughly is nearly twice the cost of a porcelain insulator, but when you take a transmission line transmitting 50,000 h.p., the cost of the insulator is such an insignificant portion of the total that it does not make much difference what it costs within reasonable limits, provided you get an insulator that is reliable.

Mr. Lambe: On that same question of insulators I do not understand that apparent change of thread there (referring to figure) and apparently they also put on the top with cement.

Mr. Buck: That drawing does not show the pin going up to the top. You see the thread on the pin up to a certain line and from there on you see the thread on the insulator. They are naturally reversed. The pin as a matter of fact goes up considerably higher than shown there in the drawing.

Mr. Dion: I would like to know what this electrose is. Is it a secret composition or what is the nature of it, roughly?

Mr. Buck: It is supposed to be a secret, I believe, but as a matter of fact it is made, as far as we can tell, of ground up asbestos, ground up mica, kaolin, and some of the gums for bond, something like shellac, pressed under hydraulic pressure.

The President: How long have you been using them?

Mr. Buck: We have had some in service something over three years.

The President: And giving you better satisfaction than any of the others?

Mr. Buck: Yes, they are very satisfactory for the voltages we have used them for, 24,000 and under.

Mr. Reesor: This long distance span across Niag-

ara River, the aluminum cables, are they proving perfectly satisfactory?

Mr. Buck: The line is now being built. It is not in service, so I cannot answer that question.

Mr. MacKeen: What scheme of lightning protection do you propose to adopt on the line to Fort Erie?

Mr. Buck: That will be worked on experimentally as we go along. There does not seem to be anything that is definitely standardized as satisfactory. We shall probably end up by trying a great many combinations. We may try the horn lightning arrester. In any case there will be reactance in series between the apparatus and the line.

Mr. Reesor: Would Mr. Buck recommend this composition insulator for a lower voltage, say 20,000 volts, or would the other insulator be quite good enough?

Mr. Buck: If the installation would stand the additional expense, I would say they would be suitable for any voltage below 24,000. We have some in use at 2,400 volts very satisfactorily. They have been placed in a district where there used to be considerable breakage from boys throwing stones, and since we have put these up there has been no further trouble.

The President: Are these very much more expensive than the others?

Mr. Buck: Nearly twice the cost of porcelain.

Mr. H. G. Steele, Pittsburg: I would like to ask where these insulators can be purchased?

Mr. Buck: They are made by a firm in Brooklyn, N.Y.

Mr. Dion: If there are no further remarks I would like to move a vote of thanks to Mr. Buck for his excellent and interesting paper. It forms a fitting closing to the papers of the day, each one describing a different plant at Niagara, and each with special features, and the whole papers taken together form one of the most instructive features of any of the conventions we have had.

Mr. J.F.H. Wyse: I have much pleasure in seconding the motion.

Motion carried amid applause.

After announcements, the convention adjourned at 10 p. m. till 10 o'clock Wednesday.

SECOND DAY.

The convention was called to order at 10.30 a.m.

The President: We will now call on Mr. Robert McKay to give us his paper on "Legal Points of Interest to Electrical Engineers."

Mr. McKay: I should explain that this paper was not written for the purpose of being presented to this Association, but it is a transcript of an address presented to the American Institute of Electrical Engineers, and I was asked by Mr. Black, a member of the Committee, to give it before this Association.

Mr. McKay then read his paper, which is printed elswhere. At the end of page two of the paper as printed, Mr. McKay added the following:

"I might also mention a case in which the decision of the Court of Appeal was handed down yesterday or the day before. A young man about 14 years of age was playing on one the bridges which cross the Rosedale ravines in Toronto, and he put his hand through the railing some fourteen inches and touched a wire of the Toronto Electric Light Company, his hand and arm being badly burned. He and his father brought action against the Toronto Electric Light Company and in the court below he recovered a verdict of some $1700. The case was taken by the Electric Light Company to the Court of Appeal and the decision the other day was that the company was not responsible. Under their by-laws and the statute they had the right to maintain that wire where it was and they evidently did not adopt the evidence that the wire should be so insulated that a boy or man could put his hands on it without injury. The ultimate outcome of the action we cannot undertake to predict."

DISCUSSION.

The President: I am sure we are all highly indebted to Mr. McKay for the very extensive and intelligent paper which he has just read to us and the amount of information we have been enabled to glean therefrom. What he has said in reference to the Bell Telephone Company and the large powers granted to them is strictly true, but perhaps it will interest some of you to know that the Bell Telephone Company came to the House at this session wanting power to enlarge their capital. They said, "we will allow you to enlarge your capital providing you have very much restricted powers than what you have had before." The consequence is the Bell Telephone Company before they could have the privilege granted to them to increase their capital had to be placed under the Railway Commissioners, the same as the railways are. The consequence is that they cannot now go and string their wires and place their poles in municipalities without getting the consent of the municipalities themselves. The same thing applies to every other company which is now asking for powers and charters before the House of Commons. For example, the Grand Trunk Pacific Company are now asking for a charter to build telephone lines, and they are placed under the same restrictions as railways are, and in addition to that they have to go to the municipalities and get permission from them, and their lines are under the jurisdiction of officials in municipalities the same as an ordinary electric light company is. If there are any questions you would like to ask I am sure Mr. McKay would be pleased to answer them.

Mr. R. M. Saxby: I have experienced the fact that a telephone or telegraph company have been on the streets for a certain number of years previously to an electric light company; have they got the right to forbid that company crossing above or going below and regulating that height themselves, or is there any height by law which the electric light company have to place those wires either above or below? They have been there for such a length of time that they practically have control of the company coming after them as to what height above or below they should place their wires.

Mr. McKay: There is no specific height fixed by law. The height depends on the principles I stated in the paper in regard to the law of negligence. If the light company applies to the telephone company as to what height they think satisfactory it is a prudent thing to do, because if the telephone company fixes a height they could raise no objection. But if they made no arrangement the light company might put its wires at such a height as it thought would not injure the telephone wire; if there was no damage they would be free, but if damage did result they would be responsible. The telephone company cannot forbid them at all, but in doing the act they do, they take the responsibility.

Mr. E. A. Evans: There is a well-known case you may have seen, a Province of Quebec case, in which the Court of Appeals laid down the rule that one company, that is the company that had previous possession of the street, was not to be interfered with in the carrying on of their business, and they ordered the removal of certain wires which they claim prevented the proper carrying on of their business and made it more or less dangerous. They practically laid down the rule that no wire should be within three feet of the other company's wires, and further, when the first company wanted to extend, to put on additional wires or anything like that, the second company would have to get out of the way and still keep the three feet away. In regard to crossing they practically laid down the rule as just mentioned.

Mr. McKay: I was familiar with that case, that is arising purely under the Quebec jurisprudence. That is hardly applicable to the Province of Ontario, and then there they hardly dogmatize on three feet but they said in the particular case three feet was enough and probably that was a safe working rule.

Mr. Lambe: The thanks of a meeting like this are always due to a man who prepares a paper, especially when it is so intensely interesting as Mr. McKay's

paper, and especially again when the author comes from another profession to address people following rather a different line from his. In court cases, which are always intensely interesting to me, and I think to everybody else, you come across several curious things. You first find suits come up where there is apparently no ground at all for damages. I knew of a case where a company ran their 2,000 volt line along the street, as their charter allowed them to do. The line had run for years without trouble. A second party came along and put a pile of lumber underneath the wire and a third party came and climbed up on the lumber and reached up and touched the wire. He brought suit against the power company. It seems hard that they should be called upon to defend themselves, as nobody could find the slightest blame, moral or legal, attaching to them. Then you find cases of negligence where people do get hurt and suffer damages but where they have no recourse. Mr. McKay instances the Hartford case, it certainly was not Mrs. Hartford's fault as far as anybody could see. I knew of a case where an elevator fell, in Toronto, and a woman got hurt. She got into the elevator in good faith; it fell, she got hurt, it was not her fault, but she failed in the suit she brought because she could not show negligence. Another case was that of a street railway, where a woman got in a car, paid her fare, bye and bye a motor rose up through the floor; besides the scare she got pretty badly hurt and was laid up for some months. She got no damages because she could not show negligence. The car it was proved was inspected in the usual manner; nothing could be shown to be wrong, and she failed on that ground. Electrolysis and telephone interference are perhaps somewhat along the same lines. Then there is the question of grounding transformer secondaries. In cases of alleged negligence it is sufficient for the defendant, I understand, to prove that they did everything that was reasonable to prevent trouble, everything known to the art. I imagine this matter of grounding secondaries of transformers will soon come under that heading, and after a while people who do not ground them will be said to be negligent. Then you come to the curious type of case. Mr. McKay instances a party stealing news from the Western Union line. I remember a case some years ago where a man was found to be buying tickets at the usual rate of six for a quarter and taking a pair of scissors and cutting them into eight for a quarter! the Street Railway found themselves up against the proposition that they were his tickets and it was his business what he did with those tickets. Again, when that point was over, did not they accept those tickets and become a consenting party when their conductor took the strips of paper the man had cut up and let him put them into the fare box as a fare? I think the matter was finally closed by a show of scaring him, they could not very well bring it into court.

Mr. Deagle: I would like to ask a question with regard to wiring, if after having obtained permission from a municipality to move my building along a highway, I come across electric light wires or telephone wires, can I compel the companies to take those wires out of my way, or on the other hand have the persons moving the building power to remove those wires out of their way?

Mr. McKay: Unfortunately there are two answers to the gentleman's question, and you have to have the particulars as to the company to which he refers and the Act under which it is incorporated in order to answer in the specific case. In the case of a large number of companies incorporated under the Dominion Act there is a special clause in the Act which provides for the removal of wires in those exact circumstances, that is the case of moving a building; and it also provides for the cutting of wires in the case of fire. In the case of a number of companies incorporated under the Act of the Province of Ontario, there is no such provision and certainly there is no law which would enable the man to compel the telephone company to remove the wires. He might with the permission of the municipality get the right to remove them himself temporarily; he would certainly be under the obligation to replace them. As a practical matter he does not need to be long concerned with it, because in the case of a telephone wire if he should cut it and put it back the remedy against him is only damages, and I think any division court judge, if the wire were put back in an hour or two, would give the company about $1.50.

Mr. Saxby: There is a question we have not discussed here in the case of a supply company undertaking a contract to wire a house, and they wire the house, and the house, previous to this, had gas pipes, and the installation of electricity and the prevention of grounding. There was a case, I undertook a contract in Whitby, and the company supplying the current was the firm responsible for connecting up that particular premises and supplying the current, notwithstanding the fact that they did not put the wiring in in the first place —and damage results afterwards. This case I have reference to was one where there was a gas installation in the house and the gas fixtures were made into combination fixtures, but the contractor did not place joints to insulate the fixtures from the ground, or prevent grounding. In this case the gasoline tank is outdoors though in some cases they are in the basement; the lightning came in, struck the upper part of the gaole, came down the pipes, injured the fixtures and put the electric light apparatus out of order, also the meter. That party seemed to think it was the operating company's place to repair all this damage notwithstanding the fact that they had nothing whatever to do with the installation.

Mr. McKay: The responsibility in the case the gentleman mentioned would be very hard to fix if the damage arose from lightning. It would probably be held in a court of law that there was no responsibility to either party. If the company supplying the current decided to leave matters as they were, nobody could compel them to do anything. If the damage on the other hand was due to the man installing the plant not having taken proper precautions he would be responsible. Lightning is usually regarded in court as an act of God, and if the man could show it was the act of a superior power he would not be held liable. The man who had the contract for the wiring should have taken the proper precautions; if he failed to do so he might find himself responsible.

Mr. J. W. Campbell: You referred to the fact that the Act will only allow franchises to telephone companies for five years. You do not say anything about what their privileges are in connection with electric light companies. Can they grant exclusive franchises to electric light companies, and if so how long?

Mr. McKay: Under the Act as at present they cannot grant an exclusive franchise at all, that is to say, they cannot bind themselves so as to preclude any subsequent council from granting a franchise.

Mr. Campbell: For how long can they grant a conditional franchise?

Mr. McKay: There is no limit. The franchise is absolute as far as that company is concerned, but it is not to the exclusion of competition. There is no limit to the time for which they can grant them if they see fit.

The President: There are a large number of electric light people who carry on plants in small towns. They have gone to the municipalities and got by-laws passed giving them permission to run their wires and carry on business in that town. No time has been mentioned in these by-laws. The question is how long can these electric light people carry on that business without the interference of the council? Can the council shut them up any time they choose?

Mr. McKay: The council, once they have granted permission and made an agreement, can never shut them up. The company can stay there as long as it exists if there is no period in the original by-law or agreement binding them, and the company exists forever if it chooses to keep its corporate existence.

The President: I have had various opinions on that point from lawyers; some say "yes" and some "no." Justice Craig in the Yukon says: "No, the council can close you off any time they like." In my town, I am going on paying no attention to that whatever. The lawyers I have spoken to on this point advise those in the future when they are getting franchises to give them a dollar or some nominal sum for it, so that it will make it binding.

Mr. McKay: I am not referring to the Yukon or anything but the Province of Ontario in making my opinion.

The President: I merely wish to say he is now Justice of the Yukon, and before he was there he gave this opinion to me. The same council can come along next year and give the same company the same rights if they want to?

Mr. McKay: Yes, you cannot shut out competition.

Mr. Reesor: I think you are trying to convey that the municipality that passed a by-law can repeal a by-law. I think it would be a dangerous thing for any council to do after they once allowed the people to invest their money in putting up lines and plant, to repeal the by-law.

Mr. McKay: If this gentleman is resting only on a by-law of a corporation he is resting on an exceedingly slim and unsatisfactory foundation, because they can repeal a by-law, but it has been specifically decided after they pass a by-law and make an agreement with the company, they can repeal the by-law, but that does not repeal the agreement and the privileges to the company. But do not rest on the by-law constituting an agreement, because it does not, any more than a resolution of the board of your company makes an agreement with the individuals to whom it has reference.

The President: I do not just catch that with reference to the agreement. In the most cases they have no agreement, as far as I know the various electric light companies. The by-laws have been passed by the council giving them permission to run their wires and carry on business in that town and no time is specified how long that shall last. The question is, can they repeal that by-law and leave you on your oars?

Mr. McKay: Yes. I was referring to the case of an agreement made under the Municipal Act as it should be. Then the company's rights rest on the agreement and not on the by-law.

Mr. J. W. Purcell: Can a council make an agreement with a lighting plant for a term of five or ten years?

Mr. McKay: Yes, a council can make an agreement to give them a privilege, so long as they do not purpose to make it exclusive, for any limited time. If they have power to make an agreement which lasts forever, they can certainly make an agreement for three or four or any number of years.

Mr. Dion: I know of a case where a company was granted powers by resolution of council, by mere resolution of the Municipal Council recorded on the minutes. This was by an oversight, possibly of both sides, not followed by any by-law. Subsequently a company obtained an exclusive charter. This was in the Province of Quebec. The wording of the legislation granting this privilege was that the company was to have exclusive rights as far as it was in the power of the municipality to give them. On the strength of that the new company attempted to drive the old company out of the field. A lawsuit ensued and was carried to the Privy Council and the old company was sustained and remained in possession. Its rights rest merely on the resolution of council. I am afraid Mr. McKay will think that the Association is a good medium for giving free legal advice.

Mr. McKay: That is what I came here for.

Mr. Dion: With regard to the distance between wires, there are a number of decisions on record which I think make it pretty safe to consider three feet as a safe distance between wires in cities. While these decisions may not be binding, there are expressions of opinion of judges in several cases which make it safe for us to consider that distance as satisfactory, that is, for ordinary city construction. With regard to the rights of a company on private property, of course we know that we do not get powers to run over private property and I think it is just as well to acknowledge that in the first place. If a man comes to you and objects to your running over a vacant lot and you know it is causing no damage, I think the best policy is to acknowledge you have no rights and offer to compromise in some way. The same thing applies to the trimming of trees. I think it is unwise to claim any particular rights in regard to the trimming of trees. It is best to try and make satisfactory arrangements with the proprietors. Of course there is another way which was suggested in the Question Box of the National Electric Light Association. The question was asked as to the best way to avoid difficulty in trimming trees? One of the answers was, "Do it between midnight and 4 o'clock in the morning." (Laughter). I think in some cases that is the only solution, but in most cases we find that a private conversation with the owner generally brings about the desired result. It is wrong to try and fight him where we have no right.

Mr. Reesor: That would include taking away the brush before daylight?

Mr. Dion: Yes. I would like to say something about stealing current. Current is being stolen and it seems quite impossible to prevent it. We have had some experience; we have tried to make examples, but it seems almost impossible to make a case. I do not like to say the law is defective in that respect because —I suppose as in every other case of larceny—you have to prove that the goods have been stolen, and that is the difficulty. You may find conditions whereby you know that a customer has used a fraudulent device and stolen current. It is difficult to prove who put that device on. Customer might say, "I hired a man to put those wires in, and I do not know what he did." If Mr. McKay can suggest any means of getting around this difficulty I think he will confer a favor on many members.

Mr. McKay: I can make no suggestion in regard to the matter. Some electrical expert will have to do that. It is purely a question of fact and of obtaining evidence to prove the fact. It is often difficult to get satisfactory evidence to prove a fact.

Mr. J. M. Deagle: I would ask if a railway company has a legal right to cut wires.

Mr. McKay: The railway company has legal right to cut wires unless you are there by legal right. If a man runs a wire over my lot I have a right to cut it unless he has superior right of expropriation and has proceeded properly to get it. Railway company's land is private property.

Mr. Deagle: I had reference to crossing on a highway.

Mr. McKay: No, they have not got the right to cut along the highway. Now there is a provision whereby all wires crossing the railway have to get the sanction of the Railway Commission.

Mr. Deagle: In this case the privilege has not been granted.

Mr. McKay: Then they have no right to cross the highway and if you cross you are a trespasser.

The President: Do I understand that if for example an electric light company has a charter from the Ontario Government and they want to go over a railway they have got to go to the Railway Commission to get it?

Mr. McKay: If you are speaking of a steam railway under the authority of the Dominion Act, that is so; you cannot run any wires across the right of way of a railway without the sanction of the Railway Commission.

The President: No matter how high, even?

Mr. McKay: No.

Mr. Reesor: If you get the consent of the Railway?

Mr. McKay: Of course. You cannot cross a power wire over the railway even if the railway does give

permission without the sanction of the Railway Commission, because that is for public safety.

Mr. Lambe: What is a power wire?

Mr. McKay: I should say myself any wire from which power was intended to be taken for use for power or commercial purposes was a power wire. A lighting wire I should think or any wire with a current above what is sufficient for telephone or telegraph wires, would be a power wire.

Mr. A. E. Fleming: That same thing applies to gas pipes?

Mr. McKay: Yes, sewage crossing a railway or anything that interferes with the right of way of the railway from the center of the earth to the upper regions.

Mr. Deagle: Where we have a number of lines crossing a railway by permission under the Railway Act and we wish to put additional lines, stringing them over the existing lines, in the event of our applying for permission is there anything in the Act by which we can get into trouble by running those wires first and getting permission afterwards?

Mr. McKay: Yes, there is; that is to say, you would be running under this difficulty, the same difficulty you are always in when you do an unauthorized act; if no damage results you won't get into trouble, but if any damage does result you will get trouble and an injunction and damages.

The President: What remedy would you suggest? There is scarcely a town in Ontario where there is a railway where the electric light people have not put wires over the track without going to the Commission; what should we do now?

Mr. McKay: Leave them alone until someone makes objection; but if you are going to string any new wires ask for permission.

Mr. Campbell: I like Mr. McKay's suggestion that when you want to get matters you don't understand yourself to have it brought before a lawyer; that is a good one. It seems to me I know of cases where they have gone to the lawyer and he has complicated things more for them.

Mr. McKay: That is very often true and I think I endeavored to emphasize in my paper that the lawyer in such matters has his limitations very sharply defined. In the first place, he must depend on the engineer to explain the situation fully to him. He must also depend on him to make him familiar with all the possible consequences; I mean all, not half. And in matters of technical expression we must depend on the engineers, so the functions of the engineers in that matter are really much more important than the functions of the lawyer.

Mr. Campbell: Even if you do explain that———

Mr. McKay: I don't think there is perfection in my profession any more than in that of the electrical engineers.

A Delegate: There is a little question in regard to the Conmee Act. I understand the Legislature has passed an act doing away with the Conmee Act. How will that affect private lighting plants dealing with municipalities?

Mr. P. H. Hoover: Mr. Conmee says the Act to which the gentleman has reference is to adopt the Conmee Act.

Mr. McKay: I speak on this subject to a great deal of correction because owing to the pressure of work on the King's Printer the acts of the last session of Ontario are not yet printed for circulation, so I have not seen the Act as passed, but as I understand it the Conmee Act is not abolished, so that of course in part renders an answer to the question impossible. You may rest assured it is not abolished wholly, because if it were all abolished then the municipality has no right to go into the gas or electric light business at all.

Mr. Campbell: I believe there has been a recent decision on the part of the Provincial Government granting certain municipalities the right to erect their own plant provided it is passed and agreed to by the ratepayers and the existing company still has the right to arbitrate with them if the town is anxious to do that. That is in contradiction to the Conmee Act.

Mr. McKay: I think I am familiar with the case you refer to, the case of Napanee.

Mr. Campbell: And Port Hope.

Mr. McKay: The one I had in mind was Napanee. That is in derogation of the Conmee Act, but of course the Legislature can pass an act any time it likes for the benefit of a private individual or a municipality. They might pass an act giving me your house and lot if they wished.

The President: There was special legislation in that case.

Mr. McKay: Yes.

Mr. Schiedel: With regard to the trimming of trees, we have a case in Waterloo where there are trees probably sixty feet high. We asked permission to trim them and were refused, but the proprietor of the property gave us the privilege of cutting them down altogether on paying him $20. That would cost probably $40, and I was wondering what the law is with regard to whether there is a certain height you can trim down to?

Mr. McKay: No, there is no height you can trim down to at all and you cannot touch those trees if they are on his property without his permission.

Mr. B. F. Reesor: When you speak about trees I can give you a case that is rather peculiar, probably unique. A certain man owned an electric plant and there was a tree on the street in front of a man's house. He got the permission of the man who owned the property to trim this tree on the street in front of the property. He trimmed it and in a certain time this proprietor died, a year and a half or so after this permission was given. The son became owner of the property and brought action against this man for trimming the tree. He took the law and the man had to pay $20 or $25 for the cutting of this tree. The judge gave him damages after he had got the permission of the owner.

Mr. McKay: He must have failed to prove the permission or else I can only say it was a very unrighteous judgment. If he succeeded in proving the permission the judgment I am free to state is contrary to law if the permission was absolutely given.

Mr. Reesor: I think it was a verbal permission.

Mr. McKay: Then there was a dispute about the permission and he failed to prove it. Where you claim a right as against the estate of a dead man you must have corroborative evidence, and perhaps he did not have the corroboration.

Mr. Dion: I might say for the consolation of the gentlemen who could not trim the 60-foot tree that we had to put a 95-foot pole in one case to get over a tree.

Mr. J. C. Archibald: In the case of trees being on the street who has control of that tree?

Mr. McKay: That was determined in the case I referred to of Judge Hodgins v. the Bell Telephone Company. There the trees were on the boulevard adjoining Judge Hodgins' property on Bloor street in Toronto and he was held to have the right of preventing the cutting of the trees notwithstanding the consent of the municipality.

Mr. W. Williams: Has a municipality the right to pass a by-law giving the privilege to trim trees for wires.

Mr. McKay: It now has. It did not have down to three or four years ago. They had not the right to trim or cut them themselves, but the Legislature in its wisdom passed a law giving the municipality the right to trim the trees. Having that right they can possibly appoint you their agents or workmen to do it.

Mr. Williams: We had to cut trees some years ago and we went to the Council and had a by-law passed and confirmed by the Legislature that with future poles placed by the Board of Works we had the right to trim; we were not obliged to put any pole higher than 36 feet above the ground. At the same time we got permission to charge the actual cost of taking

down our wires to let buildings through. The Bell Telephone have to do it for nothing.

Mr. Robert Gordon: In the case of the 60 foot tree where the proprietor would ask $20 for permission to trim the trees, what would happen if the electrical man started in to trim the proprietor? (Laughter).

Mr. McKay: It would depend on which was the stronger and what the magistrate thought of it afterwards.

Mr. R. J. Smith: In the event of the Conmee Bill being repealed, how would it affect an agreement made with a municipality previous to its being repealed? In the town of Perth some years ago the town got municipal ownership crazy and bought a little arc lighting plant. The company with which I am connected attacked the town under the Conmee Act for going into competition with a private company. The matter never came to the courts. There was a compromise made with the town by which they bound themselves to confine themselves solely to arc lighting and limiting the number of arc lamps to forty for commercial purposes; of course, they could light their streets and municipal buildings. If the Conmee Act is repealed will it affect an agreement like that?

Mr. McKay: That is impossible to answer because the repeal of the Act would probably have a clause saving existing rights. The repeal of an Act never, as a rule, affects existing agreements; it rarely does unless existing agreements are mentioned. I could not advise on that without reading the Bill and the agreement.

Mr. John Knox: I would beg to move a vote of thanks to Mr. McKay for the very able paper which has been read here. It contains more condensed and valuable information than I have seen in any other paper on the obligations devolving on companies generating and distributing electric energy to the public. I have had to consult with various lawyers on various aspects of the power question, and on one point I am advised that under the Ontario Act the municipalities have the power to do a lighting and heating business only. They have no rights to sell electrical energy for power purposes. The paper as it is printed here evidently assumes that the muncipalities have rights to sell electric current for power purposes. As I understand it, they have only rights to sell light and heat. With these remarks I beg to tender Mr. McKay a hearty vote of thanks for his able paper.

Mr. Lambe: I have very much pleasure in seconding that. One curious thing about Mr. McKay is that no matter how you try to disguise the case or when the matter come up he is able to name to you almost any suit or decision you happen to think of. Just give a few of the main outlines and he will say "Oh yes, that was the Smithfield case in 86."

The President: You have heard this resolution duly seconded. I know what the result will be. I wish to support that while I have a chance. This is certainly one of the most valuable papers we have ever had, for electric light men, and not only that but we have had one of the most valuable men standing before us to be questioned that we have ever had, and he has responded nobly and given you all the information that you wanted, and as I understand it he has given it to you as Artemies Ward says, "free gratis for nothing without paying a cent." (Applause). Now gentlemen, all in favor of this vote manifest in the usual way.

Motion carried with applause.

The President: I do not think there is much doubt about the sincerity of this vote and I have much pleasure in presenting it to you.

Mr. McKay: I am much obliged to the Association and am always glad to be of service to gentlemen with wnom I have certain interests in common at any rate.

Mr. John Murphy: In accordance with Article 23 of the constitution I beg to give notice that I will tomorrow morning make the following motion:

"Moved by John Murphy, seconded by R. G. Black: "That whereas the Constitution of the Canadian Electrical Association, which was drafted many years ago, is incomplete and is not in keeping with existing conditions, it is desirable to have it revised; therefore, it is hereby resolved that the incoming Executive Committee for the year 1906-1907 be and are hereby empowered and instructed to make such amendments or additions to the Constitution as they may deem advisable, and that the amended Constitution be put into force as soon as possible."

Mr. Murphy: When the Committee on Arrangements were making arrangements to hold the present meeting it was found that there was no hotel accommodation on the Canadian side of the river, at Niagara Falls, Ont., and the Constitution was referred to in order to see if it would be possible to hold the meeting on this side of the river. The Constitution states that the Association shall hold meetings annually in accordance with Article 14. Article 14, however, does not appear at all in the present Constitution. I think it also would be well, if I may be permitted to suggest, that the Executive Committe be empowered to secure the services of Mr. McKay or some of his learned confreres when they are revising the Constitution in order that mistakes may not occur again.

QUESTION BOX.

Mr. Dion: I received this morning an additional question to which I would like to get some answers. "Do the Canadian manufacturers of electric motors make a two h.p. and a three h.p. motor? I know of a case where a two h. p. and a three h.p. motor were bought on the same day. From measurements taken both appear to be identical." That brings up the question of rating and we might enlarge on this question and answer it in this way. Some of the representatives of manufacturers might answer it by telling us what is their rating. For instance, there is the specification of the American Institute of Electrical Engineers as to heating limits, but we know that motors have been sold in this country of a given size, so many horsepower, and other motors have been sold of presumably the same horse power for very much less money, and then the purchaser comes to you and asks your advice and you of course suspect that while the motors have been given the same rating the rating has not been made on the same basis, in other words on a similar basis one would be a three h.p. and the other a five possibly and so on. What is the custom in this country? Do manufacturers use the American Institute of Electrical Engineers' specifications or on what is the rating of a motor based? I think that would be a more complete answer than the question as put calls for. (No answer.) Evidently the manufacturers do not want to commit themselves on this question.

Mr. Lambe: If nobody else desires to answer that I would speak to that question by saying that probably the dimensions referred to are outside dimensions and that the windings and interior would be found to be very different.

Mr. Dion: Very likely in the question as put. Another question is handed in. "What remedy can you suggest whereby a company giving lights on the flat rate basis can be protected from the habit certain customers have of adding additional lamps after the rate has been struck for a stated number of lights. These conditions are made by independent wiring companies who, it would almost seem, act in collusion with customers. The question is also intended to cover the replacing of 16 c.p. lamps with 32 c.p." Here is a practical question.

A Voice: Put in a meter.

Mr. Black: It seems to me the only way to do is by frequent inspection. You have got to have someone go around at times when customers do not expect them, and catch them in the Act.

Mr. Lambe: Might I suggest that the best way is to put in meters.

The President: The party who put that question in anticipated that answer and he said that according to the

franchise they had with the town, they were obliged to give a flat rate whether they would or not.

Mr. Dion: I might say on my own account, that while I have always considered frequent inspection as the only means of preventing these abuses, I think there is a device on the market which is worthy of consideration. It is a current limiting device which causes the lights to fluctuate when a certain load is exceeded. I think that device is worthy of wider application than it has had. With it you can make a rate for so many lights and adjust your limiting device to that load and this practically prevents the owner from exceeding that load. It removes the necessity of inspection also. I believe if flat rates are necessary that some limiting device should be applied and we should not have to keep counting the lights. Then there is the Wright Demand meter, and a flat rate might be made whereby the price to be paid would be based on the load indicated on the Demand meter. With regard to the limiting device, I know of three kinds and they all work very well. Of course, they all make and break contact through mercury and are not applicable to heavy currents, but can be used up to 20 lights or so without trouble.

Mr. Lambe: Of course there are cases where meters are really not applicable and a man cannot honestly say put in meters in every case, but as a general rule they are right in theory because all the current limiting devices say in effect, you must not do any more business with me than a certain fixed amount; on the other hand the meter says go ahead and use all the lighting you want to, the more the better.

Mr. Dion: Questions 30 and 31 were not answered. They have reference to steam plants. Perhaps we could get an answer to-day. Question 30 is: "What experience have you had with Flue CO_2 gas measures used as a check on the good or bad combustion of fuel?" Mr. Wickens, can you give us information?

Mr. A. M. Wickens: This is something I cannot give you any authentic information on at all, as I have had very little to do with it. It would require some time to go into it thoroughly.

Mr. Black: Anybody wanting information on that question can read a very able paper by Mr. Stott which was read before the American Institute some time ago. I do not suppose there are many people in Canada who have had much experience with this particular device, but Mr. Stott's paper goes into it very thoroughly.

Mr. Dion: There was also a paper read before the National Electric Light Association a few days ago and which will be published later, dealing pretty fully with that question.

The President: I do not understand this question at all. I have had no experience with CO_2; can you tell us what it means anyway?

Mr. Dion: The question has reference to devices whereby the CO_2 gas contained in the stack is measured and thereby gives a check on the good or bad firing, whether there is complete combustion in the furnace or not, by measuring the percentage of that gas in the contents of the smoke-stack.

The President: You buy the gas from somebody, do you?

Mr. Dion: You buy the machine. If the meter tells you there is a certain percentage of CO_2 in your stack you determine from that whether you are getting proper combustion of the coal or not. It is held that in large plants that by keeping a check of that kind they are able to improve the firing so as to realize very large economies. You burn all the coal or most of it in your furnace instead of sending it up the smoke-stack. Question 31 is as follows: "(a) What has been your experience with mechanical stokers on small plants, say 100 K.W. to 500 K.W. capacity? (b) What saving has been effected in coal pile? (c) How do they act when boilers are forced above their capacity?" The question of using or not using stokers is quite an important one in plants of moderate size. An answer to his I think would be very useful.

The President: The gentlemen who have been accustomed to use stokers should give us their opinion.

Mr. Wickens: I think as far as stokers are concerned for the smaller plants they are too expensive; of course there are a number of stokers in the market and they are all the best, but the particular point the stoker man has to make and can make is that usually with a stoker he can burn a cheaper fuel than an ordinary boiler or with an ordinary setting and if the maintenance of a stoker is not too great he is going to make a gain; some stokers are cheaper in maintenance than others. If you can buy coal for $3 across the line and you can buy good screenings for $2.40, and if you can get anywhere near the evaporation from a pound of screenings that you can from a pound of coal, you are saving that sixty cents per ton of fuel. There is another condition under which I think the stoker can be given some credit, that is in cases where your peak load is high and you have got to hurry for a little while. I think with any well arranged stoker you can force your fires and get more steam than is possible by hand firing. When you supply the fires by hand you have got to open the fire door often and disturb the fire often, and every time you do that you are taking in a certain amount of cold air that does not need to go in. When you force with the stoker alone you simply feed the coal faster and supply more air for combustion, this air going through the fuel. In that case I believe for the medium sized plants, say 150 H.P., that the stoker is a paying investment. In cases where coal is dear, where freights are high, I think it is best to buy good fuel. We do not get all coal in any of those creenings, a cheap fuel like screenings always carries from 17 to 27 per cent. ash. That is dirt; you are buying dirt, and paying freight on it and in places a long way off it pays better to buy good coal. You can use a better coal with any of these stokers if it is small enough, and if it is not small enough it is easy to make it small enough, so I think on the whole for moderate sized plants that the stoker is a good investment. In fact, some very large plants on the other side use very elaborate stoker systems. The larger the plant is the better the stoker system must be arranged. If you have a large plant you want the stokers arranged so as to be automatic entirely. You save labor in that way and you can only save labor in a larger plant by putting in stokers that have automatic feed. So in a larger plant when well designed the stoker is all right.

Mr. E. J. Philip: There is one point not taken into account by the average person who has installed stokers, as to the actual economy they are getting. You have only to read the reports that are brought around by the various companies of tests made to see that they have not gone into the matter fully. Take the case of a mechanical stoker requiring steam to operate the stoker or to operate a fan or an engine for driving the mechanism and so on; you will hardly find one report brought around by them where they take into account anything except the fact that they evaporated more water per pound of coal with the stoker. A man might be running with a flat grate and evaporating 7 pounds of water to a pound of coal and he puts in a stoker and say he evaporates 8½ pounds of water with the same conditions. There are several things to be taken into account to offset that economy. There is first the interest on the initial investment. There is very high depreciation on nearly all the stoker plants, on some of them it is extreme, more so than with any other apparatus. Then there is the steam to operate the fans and the fact that with a stoker if anything goes wrong when the peak load is on you are worse off than with a flat grate. If anything gets out of order you are far worse off than with a flat grate and these things are not taken into account at all, and I am satisfied in many cases where they show a considerable economy if the thing were gone into from a business standpoint and all the items figured out they are actually running at a loss. In other cases they are running at a great economy; circumstances alter cases.

Mr. McKay: I know of a place at present in contemplation at Toronto, an isolated plant in a large

building, where after careful figuring and calculation, including all the items the gentleman mentions as necessary to be taken into consideration, the cost, the depreciation, the amount of power to run the stoker itself and everything that could be thought of, it was decided to install stokers for a comparatively small plant on elevators and lights for one office building.

Mr. Dion: The next question that has not been answered is No. 48, which reads: "(a) In changing a 2-phase 440 volt 60 cycle revolving field turbine type alternator to 3-phase, same voltage and frequency, two of the coils or bars were left dead, there being 48 bars connected in the first place and 46 now. What effect will leaving these bars or coils dead have on the balancing of the phases? (b) Would it not have been better to either use the 48 coils, or cut out three and use 45, having either 18 or 15 coils in each combination? I do not know which way this armature is connected, delta or star." The question does not seem to be of great practical interest. If anyone here is prepared to answer it I would be glad to hear it. Can you answer it, Mr. Hart?

Mr. H. U. Hart, Hamilton: I do not think I can answer that question without having more data as to the number of slots and so forth.

Mr. Dion: No. 57 has not been answered. "In some large switchboards, generators are connected to the bus bars solid, without the intervention of either fuses or circuit breakers. In what style of installation would this be considered good practice?" There seems to be a difference of opinion in cases whether it is best to connect solid or put a number, sometimes an excessive number of interrupting devices. I suppose the questioner has in mind where the source of energy is very large it might be a source of danger to have automatic fuses.

Mr. Murphy: I think a good deal would depend on the prime mover with which the machine was connected. In a station of moderate size operated by water power it might be a good thing to have no automatic circuit breakers or fuses, provided of course that the machine is in charge of competent attendants. The opening of the circuit breaker with the water wheel gates nearly full open, might result much more disastrously to the machinery than if the short circuit of overload were left on, especially if the gates were liable to stick fast in the open position.

Mr. Lambe: I know of a large plant where the circuit breakers were arranged so that they would not trip when throwing in another alternator. It was figured better to do this and simply let the new machine pull herself in, if a little out of phase, than to run the risk of the extra current that it would take tripping the other breakers and shutting down the whole station.

Mr. H. U. Hart: Whether or not it is best to install oil circuit breakers on the generator leads depends a great deal upon the design of the alternators. It is now the practice to design alternators so that the short circuited current is about 2½ to 3 times full load current, and therefore oil circuit breakers are not necessary, for even if you do have a short circuit no damage will be done to the generator windings, as they will easily support, for a short time, 2½ times full load current without danger. If several alternators are running in parallel there is a great advantage in not having automatic oil circuit breakers on the generator leads, for if one circuit breaker should open up this will throw more load on the other generators and their circuit breakers in turn would open up, thus causing an interruption of the service.

Mr. Dion: Question 62 is as follows: "What kind of insulated wire is considered best for 2300 volt station wire?"

Mr. Wyse: Wouldn't the best rubber insulation be most advisable to use in station wiring?

Mr. Dion: I think the latest practice is in favor of fireproofing all the wires in a station as well as insulating them and I think it is good practice. Of course there is a difference of opinion as to where you can use rubber or paper or other insulations, but I think wires, except under the floor, should be fireproofed as well as insulated. There are a number of other questions, but it is getting late and I will only bring up one more. I think it is one of practical importance to central station men.

Mr. Dion: Question No. 77 reads: "What is the latest, simplest, and best method of keeping accurate records of pole lines, extensions, transformers, etc.?" Personally I do not know of any good system. Either it is too intricate and involves too much expense and labor or it is not complete enough. If anyone has a method which he thinks is good we would be pleased to hear from him.

Mr. Wyse: As for the card index system, we have found it best to keep a record of pole lines, extensions, transformers and so forth. In my experience I have found that very efficient and very easily got at, especially in reference to accounts, a card index system giving the amount of the last bill, the date it is paid, and information of that sort in a concise form, also with reference to meters and transformers, but as I stated before, with reference to poles the expense is hardly warranted by the benefit that you get from extending that card index system to the individual poles on the pole line.

Mr. Dion: I do not think we should bring up any more questions. We are taking a good deal of time. I might add in conclusion that I should be very much pleased to get additional answers to any of these questions. My intention is to get a book published about the fifteenth of July and in the interim any questions that are sent to me will be included. The book will then be published and copyrighted so that it will not be reproduced in newspapers and the information will be obtainable only by members of the Association and those who choose to join.

Mr. Wyse: I would like the association, if it is in order at this meeting, to consider some means for making the answers to these questions of the Question Box attractive. Mr. Dion I believe has suggested before that some prizes be offered. It seems that something of that kind would be an incentive to have those questions answered more fully and would probably warrant the members of the association devoting more time to the answers, as it is a very important feature of the association and one of great interest, probably only second to the legal considerations.

The President: That is a very good suggestion.

Mr. Dion: I may say that this is a matter that it is proper and wise to bring up, but it had probably better be put in the form of a suggestion to the incoming Executive to take the matter up. At the National Electric Light Association they gave three prizes amounting to $1,000. They were for the best papers on a certain subject, and there were twenty-two papers sent in, all of them good, seven of them specially good, so good that they decided to publish those seven, although three prizes only were given. The incentive was worth while, of course; the first prize was $500, the second $300, and the third $200. This is more than we can afford to spend, but the idea is worth considering.

Mr. Wyse: The Question Box has an advantage over the papers to which Mr. Dion made reference owing to the brevity with which it brings to the association those questions and answers thereto, in preference to wading through a long paper to get what you may want.

The convention adjourned until the morning of the following day.

THIRD DAY.

The convention was called to order at 10.30 a.m.

The President: The first matter on the program is a paper by Mr. J. T. Farmer entitled "Steam Plant Accessories." If Mr. Farmer is here we would like to hear from him.

Mr. Black: Mr. President, I very much regret that we have not been able to locate Mr. Farmer this morning, but I think it will be found that he

has been unavoidably detained through illness or some important business engagement. When a man goes to the trouble of writing an important paper like Mr. Farmer has he would be on hand to present it if possible. From personal acquaintance with Mr. Farmer I know that he was anxious to be present at this meeting and anxious to present this paper. Those who had the pleasure of being present at the convention at Montreal may remember Mr. Farmer as the gentleman who took part in the discussion on the paper which Mr. McKay presented, or rather prepared, and which Mr. Wickens presented at the convention. Mr. Farmer contributed to the discussion and made it very much more interesting. I would therefore move that this paper be accepted as printed and considered as read and that we proceed with the discussion at once without any further preliminaries.

The President: Is it the wish of the Association that this paper should be taken as read? (Carried).

The President: I regret that we have not Mr. Farmer here. From a cursory glance it seems to contain much valuable matter, but no doubt he has been unavoidably detained and under these circumstances it is only right we should devote a certain amount of time to the discussion of it.

Mr. Wickens: This a very elaborate paper and one that is very valuable. Mr. Farmer has gone at the accessories for steam plants in a very lucid and efficient manner. There are very many points about it that it would be well to speak of. I regret [there are not more of our members present now. I might say that notwithstanding our great water powers there is going to be a large amount of steam used the next few years anyhow, notwithstanding that we are in this water power section of the country, and the steam end of an electrical plant is going to be an important end of a large number of plants for several years yet. The first matter that Mr. Farmer takes up is the matter of feed water. We all have trouble with the intoduction of feed water for boilers unless we live on the Ottawa river or some of those northern streams where there are no scale forming qualities in the water. We have been advised to use all kinds of compounds for the purpose of counteracting the scale. To my mind the treatment should be given to the water before it enters the boiler. It seems—if there is a means of treating water at all—it is too bad to put it into the boiler and have it form scale before treatment. That scale will cost you about 15 per cent. more fuel to produce steam. If you take the scale producing qualities out of the water before you put it in the boiler you have commenced at the right place. It always seemed to me it would pay to study out the matter of getting rid of the scale before it forms in the boiler. He also speaks about oil. In all cases where they are using condensing engines and in many places where they use engines non-condensing they have trouble with oil in the water. There is one peculiarity about oil in water. In the first place oil is the best non-conductor of heat we have.

Mr. Black: Mr. Chairman, I am pleased to be able to announce that Mr. Farmer was detained as we supposed and has just arrived. With the consent of the meeting I would like to withdraw the motion that we take the paper as read and I therefore move an amendment that Mr. Farmer be now asked to present his paper. (Applause).

The President: We are very pleased indeed to know Mr. Farmer is here and we would be very much pleased if he would come forward now and read his paper.

Mr. Farmer: Mr. Chairman and Gentlemen, I find that this paper that I have been invited to contribute to your meeting has run out to considerably greater length than was my original intention. The subject suggested to me was a rather wide one and afterwards I wished it had been a little more restricted. I propose with your permission to just briefly refer to some of the points I have mentioned. I presume that all of you who are sufficiently interested will read the paper or have already done so, and I will just draw attention to a few points that it seems to me might create a little discussion and leave it in your hands in that way.

For paper see page 189.

During the reading of the paper, in order to save time, the President nominated Mr. Fisk and Mr. Reesor as scrutineers for the election of officers.

The President: We all regret that Mr. Farmer was delayed so that he could not begin at 10 o'clock, but he has given us an excellent resume of this most instructive and well-written article and such articles as these are really better carefully read and thought out at home, so we will be able to take it home and thoroughly digest it at our leisure. Onr time now has become so much enroached upon that I think we will be obliged to defer the discussion of this and go on with our business. We have allowed Mr. Farmer to encroach on our time because I think we were amply justified in showing him that deference on account of his trouble in preparing the paper.

Mr. Hunt: I think possibly to nine-tenths of the members here Mr. Farmer's paper goes home to us more than any other paper read. (Hear, hear). We have had fine papers on hydraulic machinery, but I think nine-tenths of the members are steam engineers, and I feel very sorry we have not had more time on this paper, and I for one intend to take it home and study it out and try and benefit thereby. I have much pleasure in moving a vote of thanks to Mr. Farmer.

Mr. Black: I second the motion. I consider this one of the most valuable papers we have ever had presented before us. It is not often that central station men, except when they are designing a new plant, are called upon to consider all the various things touched upon in this paper at one time, but as central station men operating both large and small plants we all have to consider these various points at various times. We have all had trouble with feed water. The question of the best method of overcoming the difficulty is ever present. The question of loss through the stack is one we have frequently to consider, but fortunately we do not have to consider a plant that is operating all these things at one time, so this paper may be considered as a number of short and concise essays by a man who has proved himself entitled to be called an expert on all these lines, and it will be of value to us to refer to when some agent or engineer or somebody comes along advocating some change in our plant, or it we get into any special difficulty we can refer to this paper as a starting point to go into the investigation of what analysis we should make. (Hear, hear.) I am glad that Mr. Farmer has taken it up in the way he has. He shows that from a definite point of view he has a very clear conception of the subject in hand. I am pleased to say he has considered it commercially and he says the ultimate results are the ones to be considered. From a theoretical point of view you can often see a percentage of saving here and there but the fixed charges eat up all your profits. Frequently people will come around and tell you that you can make five per cent. saving here and ten per cent. there, and they lead you to believe you are losing ten per cent. Mr. Farmer on page five has shown us that it is necessary to have 20 per cent. saving in gross receipts in order to make the change advisable, so that there are a great many charges that might make a small saving that are really not desirable at all when reduced to the ultimate analysis. It is only when a person is installing a new plant or when you are forced to consider the different arguments that are raised by different men who are advocating the use of different apparatus, that a person can appreciate a non-biased opinion of this kind. Take for instance in the case of hand firing versus mechanical stokers. You will find people who will tell you hand firing is better and you will find twenty or more people advocating mechanical stokers. I think under these conditions small central station men and even those who employ engineers at high salaries will find it very refreshing to be able to

refer to this paper to get a concise clear idea of just where these savings and losses come in. I have very much pleasure in seconding the vote of thanks to Mr. Farmer for his valuable and exhaustive paper.

Mr. Dion : I would suggest that as Mr. Wickens had commenced the discussion before Mr. Farmer came in, that he be allowed to finish. Others might contribute to the discussion if they so desire in writing so that it would be printed in the proceedings. I think Mr. Wickens should be allowed to proceed.

Mr. Wickens : The paper is undoubtedly one of the best we have ever had and as Mr. Black says it is a good thing to carry home. The fact that it has gone into dollars and cents and shows conclusively from experiments that it is easy to overdo the changes and so on, this makes it very valuable. There are many technical points in the paper and my own opinion about some of the ideas expressed are not exactly Mr. Farmer's ideas, but that does not alter the fact of the paper being all right. As far as the details of the paper are concerned it is such a paper as really should be well discussed. I think Mr. Dion's idea of getting some of the members to write their opinions and send them in would be a splendid idea, I think the best we could do. As Mr. Hunt says, 90 per cent. of the central station men use steam and it is a vital point. The writing of these papers would undoubtedly be a very useful move for all the central station men.

The President : You have heard this vote of thanks which has been duly moved and seconded for this very valuable and exhaustive paper and I hope that at the same time you are conferring this vote of thanks on him you will excuse me for having encroached on your time so much as I have in giving this paper undue time for discussion, because I know you will pardon me for having transgressed the rules in this way. All in favor manifest by the usual sign.

Motion carried with applause.

The President : I am glad to know you have excused me and I have great pleasure in presenting this hearty vote of thanks to Mr. Farmer.

Mr. Farmer : Mr. Chairman and Gentlemen, I thank you all very heartily for the way in which you have received this paper. At the same time I must apologize sincerely for trespassing so much on your time. It was impossible for me to leave Montreal until last night and the best connection does not get here until 10 o'clock. Although there was not any late train or anything specific upon which I could blame my absence, at the same time I feel sorry for the demands I have made upon the time at the disposal of the meeting. I would like to say that I think the suggestion made by one speaker in regard to writing discussions on this paper is good. I had in mind in writing it the idea that it would possibly bring forth a good deal of discussion and even perhaps some heated discussion. I spent a considerable amount of time on it, and I should feel very much rewarded if I could see later on some views of other members of the Association on some of the same points. I think one point about getting up a paper of this kind is that it is of a great deal more benefit to the man who writes it than to anyone who hears it, because it makes him think about these things; and I think if you will take up some of these points and undertake to correct my ideas upon them it would be of great benefit to yourselves, and I should appreciate it very much. (Applause).

Mr. Murphy then moved the motion of which notice was given the previous day, as follows : "That whereas the Constitution of the Canadian Electrical Association, which was drafted many years ago, is incomplete and is not in keeping with existing conditions, it is desirable to have it revised ; therefore, it is hereby resolved that the incoming Executive Committee for the year 1906-1907 be and are hereby empowered and instructed to make such amendments or additions to the Constitution as they may deem advisable, and that the amended Constitution be put into force as soon as possible."

Mr. Murphy : It was suggested that a committee be appointed—at one of the early Executive meetings—to take up the question and work connected with the revision of the Constitution, but it was found that it would involve such a large amount of work that it was realized this would be an impossible task ; consequently this motion is to get over the difficulties in question.

Mr. Black : I have much pleasure in seconding that. The reason for bringing in this motion is that we have found in the present Constitution, in some unknown way, some articles have been apparently lost, and in order to meet the growing ambition of the country it is necessary that the Constitution be thoroughly brought up-to-date.

The President put the motion, which was carried.

The President : There is a matter which I think we are quite justified in taking up just now and that is with reference to the Queston Box which Mr. Dion has carried on so ably and so efficiently. It is necessary to appoint somebody to look after that and perhaps someone will have some suggestion to make with reference to it. I do not think it could fall into better hands than those it is in now.

Mr. Murphy : I do not know whether Mr. Dion would again accept the honorary position of Editor of the Question Box, but whether he agrees to accept it or not I think this matter should be left to the Executive Committee.

Mr. Hunt : I think if you are going to leave it to the Executive Committee to arrange for an editor, the least you can do is to move a vote of thanks to Mr. Dion for the able manner in which he conducted the Question Box during the past year, and with the request that he would also accept the Editorship for the coming year.

Mr. Wyse : I second the motion. I think the Question Box is a very important feature of the Association and could not possibly be conducted in any better way than Mr. Dion has conducted it. I have great pleasure in seconding Mr. Hunt's motion.

The President : You have heard this resolution as moved and seconded. I have said so much about it I am afraid I would be repeating myself so I will not say anything more. You all know how well it has been done. The motion was put and carried.

Mr. Dion : Mr. Chairman, there was really no need to vote me any thanks because the members individually have expressed so much satisfaction with the work that I feel I am fully rewarded for anything I had to do in connection with it. In regard to taking it for another year I think it would be a wise thing to leave the matter to the incoming Executive. I do not believe in the principle of electing a body and then tying their hands. If the Executive wish me to do so and I think I can do so, all right.

Mr. Wyse : Is this not more a prerogative of the whole Association than of the Executive? I think it is a question that interests probably all of the members of the Association, and the appointment of somebody to look after it if Mr. Dion is not going to continue—though I hope he will—should be decided by the whole convention and not left to the Executive.

The President : I think it has been decided by the convention, and the Executive will see that Mr. Dion is provided with a sufficient amount of wherewithal to see that the work is done without too much labor on his part. Now, it would be well to provide for votes of thanks to the various institutions and executive bodies that have helped to make our stay here so pleasant and so agreeable, and if somoene would move that the Secretary be instructed to do this work I think it would be well.

Mr. Purcell : I would move that the Secretary be instructed to forward the necessary votes of thanks to all those who have extended courtesies to us while in Niagara Falls. He knows who they are.

Mr. Rust : I take pleasure in seconding the motion.

Mr. Dion : In case the Secretary is not aware of it, Capt. Carter, who is in command of the Maid of the Mist, was very cordial in his invitation, and he ex-

pressed regret that more of the members did not take a trip on the Maid of the Mist, so in case the Secretary has not his name he will please take it.

The President put the motion, which was carried.

Mr. Purcell: Of course, in that is included the municipalities on both sides of the river.

The President: Oh, everybody.

The President: Now, it will be necessary that we should arrange for the next place of meeting. Our by-law is not very pointed on that and perhaps there will be some way of getting out of it, leaving it to the Executive or some other way. There are some difficulties we have to contend with in connection with the meeting this year that we could hardly solve to-day, and perhaps it would be advisable to leave it to the Executive to work it out. However, I will leave it with yourselves.

Mr. Evans: I would move a resolution that the place and date of meeting be left in the hands of the new Executive with the suggestion that they should seriously take into consideration the question of meeting in Montreal. I have it in mind that it is quite possible that next year Montreal will be the meeting place of the American Street Railway Association, and I would like if possible that the new Executive should try and arrange to hold a meeting in Montreal at about the same date as the American Street Railway Association, and I can assure you that if that can be arranged it will lead to the finest exhibits of electrical apparatus from a transmission point of view and a transportation point of view that we have had for a number of years. About twelve or thirteen years ago we had a somewhat similar meeting in Montreal, and I can assure you it was one of the finest we or the Street Railway Association ever had. The new Executive should take this matter into consideration. For myself and the Montreal members we will try and make the meeting successful.

Mr. Wyse: I take pleasure in seconding that motion. I remember with a great deal of pleasure our meetings in Montreal, and the courtesy we were shown by the hosts there, the Street Railway and the light and power interests in the city.

The motion was carried.

The President: The next order of business is the election of officers. I have named the scrutineers and they are at work installing the ballots. The first officer to be appointed is a President. You know the usual order of procedure that the First Vice-President steps up unless there is a very much better man for the place. However, it will now be for you to nominate the President for the incoming year.

Mr. Burran nominated Mr. R. G. Black.

The President: There does not seem to be any opposition. How would it be for us to do as they do sometimes in the election of the Pope, just elect him by acclaiming in this way. (Clapping hands). All in favor? (Loud applause). I am glad to know you have promoted our Vice-President to the position he so much deserves by his past labors, and I know in him you will have a most efficient and excellent officer. (Applause). It would be in order for the Second Vice-President to step up and become First Vice-President, but I understand he is going to resign his position and consequently he will not be eligible for the First Vice-Presidency. If that is so perhaps Mr. Murphy will make it clear.

Mr. Murphy: I beg to move that the office of First Vice-President be tendered to Mr. R. S. Kelsch, of Montreal. I beg to mention, in this connection, that I do not quite agree with the President that the Second Vice-President should always become First Vice-President, and that the First Vice-President should always be made President. I think that at each meeting the members should look around and discover the most likely candidate to fill each position. In the selection of our President on this occasion I do not think a better move could have been made than by doing as we have done in electing Mr. Black. I would like to see Mr. R. S. Kelsch as our First Vice-President because I feel he is in a position to do more for the Association at the present time than any other member. He, as you all know, is connected with perhaps the largest electrical enterprises in this country outside of Niagara Falls, and he has an immense number of young men connected with him who would, I feel, be willing and anxious to take a hand in matters concerning the Association if Mr. Kelsch were elected to office. I went out of my way to consult Mr. Kelsch and asked him if he would accept a position on our Executive Committee. He first of all told me he would not; he was so busy a man that he had had to refuse work, in which there was money; consequently, considering only his own convenience, he did not feel like devoting much time to anything which was simply honorary. However, he has, I am pleased to be able to say, consented to accept such a position if it is tendered to him.

The President: If there are no other nominations we declare him elected by acclamation. The next in order will be the Second Vice-President.

Mr. Williams nominated Mr. Chas. B. Hunt, of London.

Mr. Hunt: Mr. President, I thank Mr. Williams for the honor he has done me, but I think I must tell you that I an not a candidate. I would have very much pleasure, however, in assisting any of the young men here to fill the office of Second Vice-President.

The President: I am sorry to hear this and I think you will be too. Mr. Hunt has been one of our best men. (Applause). He does not look very old and I think there is a good deal of work in him yet. He may class himself as an old man, but we do not.

Mr. Hunt: I think it is much better to have a younger man, and there are a great many of them here for you to choose from who are fully qualified to fill the office.

Mr. Dion: Are we to understand that Mr. Hunt will not accept under any circumstances?

Mr. Hunt: Yes, that is final.

Mr. Dion: If a little encouragement were needed I would feel disposed to give it to him, for I certainly feel he is the man for the position.

The President: Is that final?

Mr. Hunt: That is final, Mr. President.

Mr. Wyse nominated Mr. J. A. Kammerer, of the Cataract Power Company, for Second Vice-President.

Mr. Black: I happen to know Mr. Kammerer very well and I think Mr. Kammerer would very much rather see somebody else in that position. With that in view I would like to nominate Mr. W. N. Ryerson, the operating superintendent of the Ontario Power Company. He is a new man, recently come from New York to take charge of the operation of one of the three large power companies, and I think we should in some way attempt to interest these new members who are coming amongst us, and I feel sure Mr. Ryerson will be a very valuable addition to our board of officers.

Mr. Burran nominated Mr. L. W. Pratt.

The President: If there are no other nominations we will go to the ballot.

Mr. Murphy: I would like to get the following information: Have the gentlemen who made these motions the consent of the members whom they have nominated? Do they know whether they will accept office? The member beside me also asks if these gentlemen are active members.

The President: They are, yes?

On further question as to Mr. Ryerson's eligibility, the Secretary stated that Mr. Ryerson's application for Active membership was passed at the Executive meeting the previous day.

The ballots were cast, resulting in the election of Mr. Ryerson as Second Vice-President.

The President: We may now receive nominations for Secretary-Treasurer.

Mr. Dion: I have much pleasure in nominating Mr. T. S. Young, Assistant Secretary-Treasurer. Mr. Young is known to all of you as having assisted the Secretary at this meeting. For some years he has been in close touch with the Secretary's work and for the

last portion of the year he has been recognized by the Executive Committee as Assistant to the Secretary. The Secretary now dropping out, I believe Mr. Young is fully conversant with the work of the office, more so than anyone else can be, and therefore I trust he will be elected.

Mr. Hunt: I have much pleasure in seconding that resolution. Those who were at the convention last year became known to Mr. Young and saw the work he did, and also see the work he is doing here. I think he is more qualified to fill the position than a stranger.

Mr. Burran: I would like to nominate Mr. Archibald Smith.

Mr. Wickens: I would like to second that nomination. I think Mr. Smith would make an efficient Secretary and he has a good deal of "go" in him.

Mr. Saxby nominated Mr. Hicks, but the latter declined the nomination.

On ballot Mr. Young was declared elected.

The President: It will now be in order to receive nominations for the Executive Committee.

Mr. Wyse: It is with pleasure that I note that we have some new blood in the Executive. With all due respect to the old Executive, I think when they so far forget themselves as to eliminate the attractive and important feature of the banquet it is time we had some decidedly new blood. I take pleasure therefore in nominating Mr. L. W. Pratt and Mr. A. M. Wickens.

The members of the Executive who continue for another year were announced to be Messrs. James Robertson, W. Williams, Lewis Burran, H. O. Fisk and J. W. Purcell.

Mr. Black nominated the names not scored off the ballot at the present time, that is, the five elected two years ago.

The following were later reported as elected: Messrs. A. A. Dion, B. F. Reesor, C. B. Hunt, J. J. Wright and L. W. Pratt.

The President: While the ballots are being counted there is an important item we might safely attend to. You know we are losing our old Secretary-Treasurer, who has performed his duties very efficiently for a long time, and I think it would be only right for some of you to make some remarks with reference to it, and give him such a send-off as I think he deserves.

Mr. Murphy: In view of the long services of Mr. Mortimer, our retiring Secretary-Treasurer, I beg to move that the hearty thanks of the association be tendered to him, and that a suitable testimonial be presented to him. The matter of the testimonial I would like to leave in the hands of the incoming Executive Committee. (Applause).

Mr. J. J. Wright: I second that.

The President: You have heard this resolution as moved and seconded and I certainly think it will receive unanimous support. You know under his supervision our Association has grown until it now has assumed very large and respectable proportions, and we expect under the new management it will grow and become increasingly great, and we look forward to a bright future for this Association, and if we all work faithfully together I have no doubt we will atain that object. Our old Secretary-Treasurer has performed the work in an efficient manner. Perhaps he is not perfection; we are all liable to do things that some people do not think should be done in that way; but he has been an efficient officer. All in favor of the resolution manifest in the usual sign. (Applause). While we are on this point and as I am the retiring President, perhaps it will not be out of place for me to give a word of advice to the Executive. As I have just said, we are growing now to be a large institution and we expect greater things. We expect more work from our Secretary perhaps than we did from our last one. We have in our hands something like $1100, and I think it is only right, and I know our newly-appointed Secretary will not find fault with me when I say that the new Executive Committee will see that the proper bonds are made out by Mr. Young at the expense of the Association whereby this amount will be guaranteed to us if any difficulties whatever arise. It is purely a matter of business and I know Mr. Young will not find fault with me for saying it.

Mr. Black: There is another matter I would like to bring before the members here and that is a very hearty vote of thanks to our worthy Chairman. I think he has filled that office in a very admirable way and he seems to have the faculty of saying the right thing at the right time. He has done what few past presidents have been able to do, to keep up to time.

Mr. Williams: I have much pleasure in seconding that. We have had a splendid meeting; everything has been taken up and conducted in a thorough manner.

Mr. Dion: As you cannot very well deal with this matter which concerns yourself so particularly, I would ask the President-elect to put the motion.

Mr. Black: It is a great pleasure I have in asking you to vote on this important matter. Those in favor signify by a hearty hand-clap. (Loud Applause).

President Wright: Mr. President, I recognize for the first time that all these hand-clappings have been for me. I am certainly very much obliged to you indeed for the warm words of commendation which you have said in my behalf. I recognized at the outset that I had a very important position to fill, that I was following able executive officers, and it would be very difficult for me to come up to anything like the standard of excellence they had set before me. However, I am delighted to know that even in part I have helped to perform the functions that have devolved upon me in a way that has been acceptable to you. I thank you most heartily, therefore, for this vote of thanks. There is still one other thing regarding which I would like to make a suggestion. I would like to suggest to Mr. Dion that whenever he is getting these questions and answers published, that he have them invariably printed in the same shape so that we can keep them together and make a very nice volume for reference. I am sure you will all appreciate that when you once have it brought to your notice, and I know Mr. Dion will act in accordance with it.

The convention was then declared adjourned *sine die.*

SOCIAL FEATURES.

Wednesday afternoon was devoted entirely to visiting the hydro-electric power plants on the Canadian side of the river. By courtesy of the International Railway Company, special cars were provided free of charge for the members and guests, and several hours were spent inspecting the magnificent works of the Ontario Power Company, Canadian Niagara Power Company and Electrical Development Company. Every possible courtesy was extended to the visitors by the officials of these companies, to whom the thanks of the Association have since been formally tendered. The trip through the Electrical Development Company's tunnel was greatly enjoyed by the participants.

A trip on the Gorge Route, with searchlight illumination, had been arranged for eight o'clock Wednesday evening, but owing to rain had to be postponed. A smoking concert was held in the Convention Hall at ten o'clock, which proved to be a very pleasing entertainment.

By the kindness of Capt. Carter, free tickets to the "Maid of the Mist" were given to all persons wearing Association badges.

Although the business sessions ended about one o'clock on Thursday, many persons remained at the Falls during the afternoon, visiting the power plants on the American side and other points of interest.

The Local Committee, to wohm the Association is indebted for the very complete arrangements, was composed of the following: R. B. Hamilton (Chairman), J. W. Campbell, J. A. Kammerer, N. S. Braden, Geo. C. Rough, W. A. Pearson, W. N. Ryerson, Mayor Slater (Niagara Falls, Ont.), W. L. Adams, D. F. Seixas, Munro Grier, Capt. R. S. Carter.

STEAM PLANT ACCESSORIES

BY JOHN T. FARMER

The nineteenth century was the age of steam. It remains to be seen whether the twentieth century is to be distinguished as the age of hydro-electric power or of the internal combustion motor or perchance of some hitherto unsuspected source of energy. However that may be, the practical outlook in this year of 1906 is that for many purposes the steam plant is, all things considered, the most suitable source of power available.

Since the first practical application of the principles of steam generating and using, the art has been, in common with all others, elaborated by the cumulation of thought on thought and experience on experience. To review all that has been done in this way would fill a library ; to consider even superficially the accessories that have come through the searching test of years of trial, and stand to-day as accepted components of modern steam practice, would easily demand the capacity of many volumes. This is what the present paper aims to do in a few pages, so it must necessarily take rather the form of a synopsis than of a detailed description of all the features which it will attempt to cover. Even in this form it is hoped these remarks may be of value, as possibly having the effect of drawing attention in some quarter to a phase of the subject up to now overlooked, and so possibly initiating a closer study of the neglected point to the benefit of the plant as a whole.

The main featutes of a steam plant, the steam boiler and the steam motor, whether engine or turbine, may for the purposes of the present discussion be best taken as accepted facts. Any one of a hundred engines may be selected and set to work with any one of a score of boilers, and the results, if the apparatus is chosen with due consideration of the conditions, and given a fair show by watchful attention and diligent care in maintenance, will be almost uniformly satisfactory. The boiler makers may be left to worry with the design of the boilers ; and the engine builders may be trusted to wrestle with entropy curves, and the innumerable other problems that come into their special field ; but where the power user may profitably expend his thought is in seeing that neither boiler nor engine nor the effectiveness of the plant as a whole be allowed to suffer through the omission of any accessory details which can be shown to be practically and commercially desirable. This will prove a more profitable field for his mental activities than in indulging in vain regrets that he cannot exchange the evils he knows of for others with which he is less familiar.

The term commercially desirable is used advisedly : for it is in reality the crux of the whole matter, and it is proposed to treat this subject from a strictly commercial viewpoint. There may be details of a plant which are scientifically perfect in design, and technically faultless in operation, which yet, when subjected to the test of a financial statement, are found wanting in that they do not earn a dividend on their cost, or that the dividend they do earn might be obtained in a simpler and less costly way.

This question of return on investment is very largely one dependent on conditions ; what is advisable for a large plant is not necessarily so for a small one : and a conclusion arrived at for a plant designed for constant service cannot necessarily be stretched to cover a plant intended for emergency use. In discussing the various adjuncts which go to make up a complete steam plant an attempt will be made to indicate the limitations of each.

The subject of a steam power plant naturally subdivides itself into two heads, which for conciseness may be referred to as the steam generating plant, and the steam using plant. The various adjuncts of the plant can mostly be classed under one or other of these heads, though there are some which are interdependent, and this makes difficult a perfectly logical sequence in dealing with the subject.

FEED WATER TREATMENT.

For the efficient production of steam one of the essential conditions is that the plant should be kept up to a good standard of preservation. One of the chief causes militating against this in many localities is the tendency of the water to deposit salts on the heating surface during evaporation, the phenomenon known as scaling. This is harmful in two ways. Firstly, the scale, being a comparative non-conductor of heat, offers a greater resistance to the passage of heat from the hot gases to the water, and consequently more heat remains in the gases and passes away to waste. Secondly, the scale insulates the metal from the cooling water, while the other side is subject to the temperature of the hot gases, whence the tendency of the metal is to assume a temperature approaching that of the gases rather than that of the water. If the scale is heavy enough to cause this rise of temperature of the metal to become extreme, it may reach a point at which the tensile strength of the metal becomes reduced and then the results may be disastrous.

The seriousness of this action depends on the hardness of the water, which varies in different localities. In Quebec and the northern part of Ontario the water got from ordinary sources is practically free from salts, and the formation of scale is not a serious question. In southern Ontario, on the other hand, and still more so on the prairies, the water is very bad, and the question of scaling has to be expected and faced.

There are several ways of meeting this problem, which will be briefly referred to.

An elementary method of meeting this difficulty has been to place in the boiler some non-mineral matter subject to decomposition, such as bark of a tree, or any vegetable matter, or even a dead dog. The idea is that the decaying matter becomes distributed through the scale formation, rendering it less homogeneous and more easily removable.

The action of a small quantity of kerosene placed in the boiler is very similar.

A very common and simple expedient is to apply to the feed water a chemical compound adapted to counteract the effect of the chemicals in the water. Thus chemicals may be applied which convert the salts dissolved in the water into insoluble salts at low temperature, and so precipitate them in loose particles. An alternative action is where salts soluble in hot water are formed, which remain in solution until got rid of by means of the blow-off. Any loose deposit can also be cleared away largely by this means, so it is evident that careful attention to the blow-off is important in conjunction with any such water treatment. The action of a compound designed for the treatment of any particular water is usually a combination of the two indicated above. The chemistry of water treatment is a study in itself.

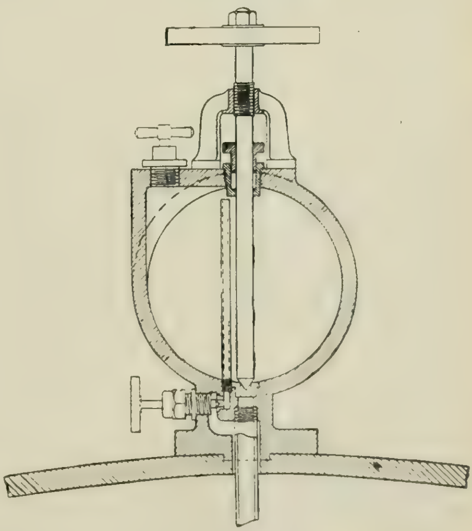


Fig. 1.

The compound used for treating water usually takes the form of a mixture of caustic soda or soda ash or sodium phosphate with other ingredients, which mixture should be based on the results of an analysis of the water used for boiler feed. This compound can be applied to the feed either in a tank before it goes to the boiler, or, by means of a special apparatus, directly into the boiler. See Fig. 1. The regulation of the correct amount of compound introduces a difficulty which can only be approximately solved, and hence the process is apt to be only a partial solution of the difficulty.

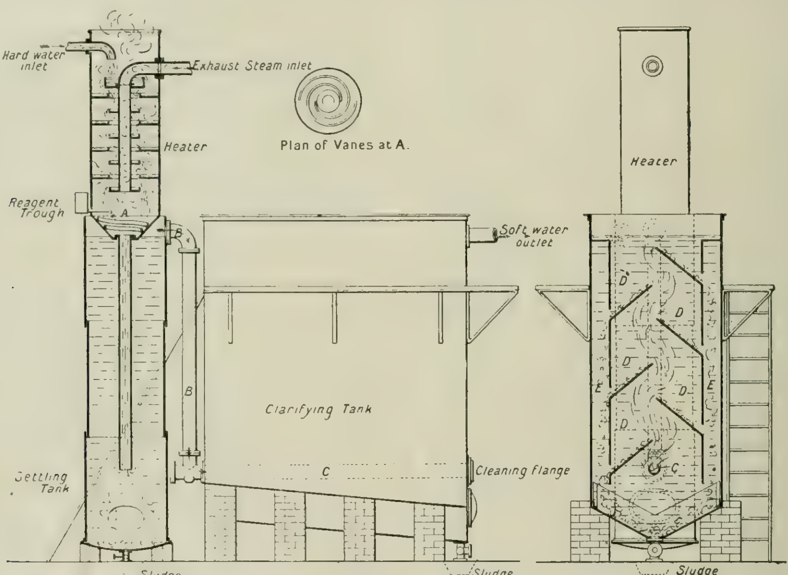
To illustrate the commercial aspect of this method of treatment a fairly typical case may be cited. Two boilers out of a battery of three evaporate 60,000 lbs. of water per working day of 10 hours, one being held in reserve. The water is such that it is necessary to close down a boiler every two weeks in order to clean out the hard deposit, a process which requires the labor of two men for five or six hours, at a cost of, say $3.00 for labor, or $1.50 per week. It is estimated that suitable material

for softening the water applied in suitable quantities would cost $1.65 per week. In this case there is no apparent saving in expenses by the use of the compound; but there is the consideration of the obviating of the hard usage of the boiler in the process of cleaning, and the inconvenience of having the boiler so frequently out of service, which represents a considerable actual loss beyond the net cost of labor for cleaning.

In regard to these compounds, there are many of these advertised and placed on the market as standard articles; and it is to be feared that some of them are to be regarded with suspicion as only imperfectly adapted to fulfill the function expected of them. In the case above mentioned the cost was estimated to cover a compound prepared with due consideration of the chemical analysis of the water.

If the water is to be chemically treated a more scientific, but obviously more elaborate and espensive method of doing it, is to instal a distinct plant for water treatment before it goes to the boiler. The features of such an apparatus should be a device for regulating the correct admixture of the chemicals used, an effective system of mixing them with the feed water, and an effective settling basin to free the feed water from the precipitated matter, before it is taken on for use in the boiler.

A brief description will be given of such an apparatus designed by Mr. T. Roland Wollaston, M.I. Mech. E., of Manchester, as it seems to contain the features in a well-thought-out form which should be looked for in an apparatus of this kind. Fig. 2.



Part Sectional Elevation   Cross Section of Clarifying Tank.

THE WOLLASTON WATER SOFTENER.

Fig. 2.

The apparatus includes first of all a reagent tank, preferably in duplicate so that a solution of the reagent can be accurately prepared without any interruption of the process. This solution is prepared by hand as often as a supply is required. The solution is pumped into the mixing tank by means of a small pump geared directly to the main pump. In this way the proportion of the reagent solution to the feed is kept constant at whatever speed the pump may run. It is found to assist the process of precipitation if the feed is pre-heated by means of exhaust steam, and a heater is provided for this purpose. Where exhaust steam is not available or insufficient, it is sometimes found desirable to use live steam. This, of course, is not a loss, as the heat of steam so used is returned directly to the boiler. On the other hand, it is stated that the apparatus works efficiently with cold water, but the action could not be expected to be as rapid. The mixed feed and reagent passes down a pipe to the bottom of a plain cylindrical settling tank, and a large part, though not all, of the precipitated matter falls to the bottom of this tank, where a valve is provided for occasionally blowing it off. In order to completely clear the water of suspended matter, an ingeniously designed clarifying tank is provided. It is recognized that the precipitate will be suspended at all points in the volume of water, and if the volume be quiescent, this suspended matter will slowly sink until it reaches a solid substance on which to rest. To reduce the distance through which the solid matter has to descend a series of inclined shelves are arranged in the clarifying tank. These are so situated that they form a series of baffles past which the water slowly rises. The inclination of the shelves is made greater than the angle of repose of the substance which collects on them, so that the mass of suspended matter tends to slide off into side chambers in which the water is absolutely still, and so down to the bottom of the tank. Here there is provision for blowing off, as well as arrangements to admit of more thorough cleaning when necessary.

The annexed table shows estimated costs for complete plants on the lines of the foregoing. The instances given are taken from typical installations in England, and to cover higher labor and other costs in this country the amounts have been increased by 30 per cent. : —

Capacity of plant. Gallons per hr.	Boiler h. p. A S M E rating.	Cost.	Cost per boiler h. p.
1,000	330	$1,820	$5.46
2,000	670	2,080	3.12
5,000	1670	3,575	2.15
10,000	3300	5,850	1.95

Again, another method of dealing with scale forming matter in the feed water is by means of such an apparatus as the Hoppes feed water heater and purifier. This heater is made in the form of a strong cylindrical steel plate tank capable of withstanding boiler pressure. The feed is heated as much as possible from sources of waste heat before being pumped to the heater on the way to boiler. Then in the heater it is supplied with live steam, which heats it up to boiler temperature on the open heater principle. The heat given up by this steam, it will be noticed, is returned to the boiler in the feed water, so it is not lost. The idea is that, the water being heated up to boiler temperature, the salts which become insoluble in water at high temperature will be deposited in the heater instead of the boiler. The heater is provided with trays over which the water trickles and on which the scale is deposited. These can be removed periodically and cleaned.

Where the water is very hard or very expensive it is worth consideration to condense in a surface condenser and use the same water over again. This at once introduces another difficulty of the same order as the hardness in the water, in the danger of oil getting into the boiler and collecting on the heating surfaces. This has the effect of partially insulating the metal from the cooling effect to the water, previously alluded to in connection with scale, which is evil in a similar way. Precautions should be taken in such a case to do all that is possible in the way of separating the oil. Many oil separators are available, constructed on the general principle of placing ob-

structions in the direct path of the passing exhaust steam to catch and detain the particles of oil. The effectiveness of such apparatus probably depends to a large extent on their not being expected to do too much. That is to

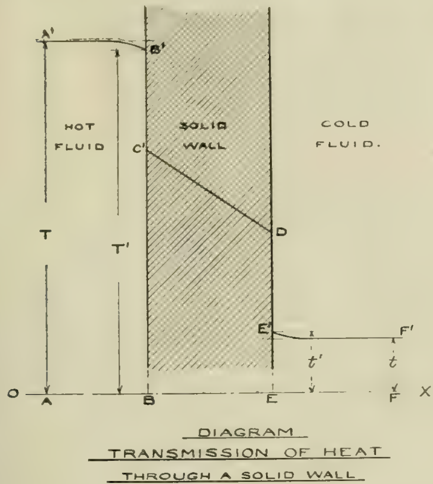


Fig. 3.

say, any apparatus of this sort, to be effective, should be amply large for the work to be done.

Another method is to separate the oil from the feed water after condensation by means of a filter. One consideration which makes this less desirable than separation from the exhaust steam is the fact that it does not keep the oil out of the condenser. The collection of oil on the condensing surface will soon affect adversely the efficiency of that surface.

A desirable feature in connection with a plant using condensation for boiler feed is a large hot well or settling tank provided with facilities for drawing off the oily scum which will tend to rise to the top; the water intended for consumption being drawn from near the bottom. The larger such a tank can be made, of course, the better. In this connection it is worth noting that such a tank should not be constructed of concrete, as the presence of oil has a deteriorating effect on that material.

The thing which renders difficult any effective separation of the oil from the water is the fact that the oil is suspended in such minute particles, constituting what is known as an emulsion. The state is such that the effect of viscosity seems to be to render it permanent under ordinary conditions. The whole subject would seem to be one to which scientific experiment might very profitably be applied.

Recent modifications of water softeners have been made with the special object in view of taking care of the oil in condensation returned, which is rightly regarded as a most important element in the problem. The reagents used are lime, soda and alum, and the results obtained are said to be very satisfactory, so that such apparatus is being installed very generally in electrical stations in Great Britain.

Instances are on record where good results have been obtained by the use of a centrifugal separator. This method has the objection that it involves the use of a piece of somewhat complicated mechanism, requiring appreciable power for operation. It would hardly be resorted to where the object sought could be attained by other means.

In a case where trouble is found with suspended oil in the feed water it is worth noting that that trouble would be minimized by taking care to use a high-grade cylinder oil, with a high flash point. In this way the oil vaporized and carried over with the exhaust steam would be reduced to a minimum.

This is an attractive feature in connection with the use of steam turbines, as in that case practically no oil is used so as to come into direct contact with the steam.

APPARATUS FOR REDUCING COSTS OF OPERATION

Having provided such adjuncts as are necessary for the safety, or desirable for the convenient operation of the plant, it becomes a duty to examine the features which cannot be classed as necessities and may entail extra trouble in operation, to determine whether they are economically desirable.

There is in every operation a certain amount of waste, partly unavoidable and due to limitations which are a part of the natural law with which no sane man seeks to interfere, and partly avoidable as to which the rational course is to study to what extent they are practically so. In steam generation as in other operations there is no such thing as getting something for nothing, but the force of the proverb that a penny saved is a penny gained is as great as in other matters.

As an introduction to this part of the subject, it will be well to summarize the avenues of waste. The fuel is burnt, but not quite all; a small proportion manages to slip away with the ashes in usually a partially consumed state. Then the heat derived from the fuel burnt is transferred to the products of combustion, and thence to the steam generated. In this latter transference there is a loss, as all the heat is not transferred, some escaping by conduction and radiation, and the gases escape at a higher temperature than that of their original components at the commencement of operations. Of the heat imparted to the steam, a portion is lost in condensation before the steam has been conducted to the point where it is to be applied. In the application of this steam in the motor there are serious losses due to cylinder condensation, effect of clearance, and so forth, which, being part of the engine problem, will be left out of consideration in this discussion. Finally, before the steam has spent in useful work more than a fraction of the heat energy still remaining in it, the large balance has to be thrown away in accordance with the inexorable demands of the second law of thermodynamics, that mysterious condition which every engineer has, at some time and in some form, seen the necessity of acknowledging. Recapitulating, the mechanical wastes to be considered are:—

Loss due to unconsumed fuel
" " " radiation and conduction.
" " " escaping gases.
" " " condensation.
" " " heat in exhaust

Taking a broad view of the subject, the mechanical wastes are not the only ones to be considered, just as the fuel cost is not the only charge for running expense on the plant. These costs include:—

Fuel.
Water.
Other materials for operation.
Labor.
Materials for repairs.
Labor for repairs.

To completely analyze the results of any appliance, all the items of saving due to, or expense chargeable against it under the foregoing headings should be collected in a debit and credit account and the net results determined. This net result, if a profit, represents only the current profit, which, again, has to be compared with the fixed charges due to the appliance, which are to be arrived at from a careful consideration of all the expenses, direct and indirect, of installation, and the fair interest charges thereupon, and the annual charges which experience shows to be necessary to be set aside for depreciation.

A general formula can be devised to express the results of a known saving in heat units as an annual saving in money, and hence as a percentage return on the estimated

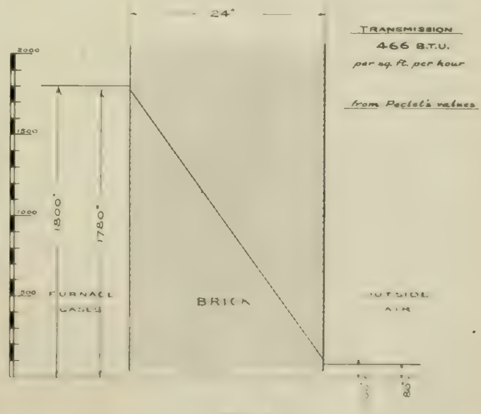


Fig. 4.

cost of installation of the apparatus required to effect that saving.

Thus, suppose it is satisfactorily demonstrated that by means of certain apparatus S B.T.U. per hour can be returned to the system in the form of steam suitable for use.

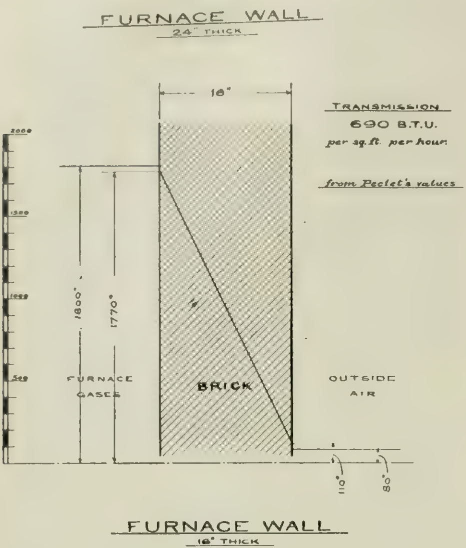


Fig. 5.

Allowing for the efficiency of 70 per cent. of a steam generating plant, one pound of coal as ordinarily procurable in Canada containing about 13,000 B.T.U., will afford 9,000 B.T.U. of useful heat supplied in the form of steam.

Then the above saving is equivalent to that of $\frac{S}{9000}$ lbs. of coal per hour.

With coal costing U dollars per short ton, the hourly saving has a monetary value of $\frac{S}{9000} \times \frac{U}{2000}$ dollars.

Before this can be expressed as an annual return, two factors have to be considered.

The apparatus will be in full service for a certain number of hours H per day. This number H has to be determined not only from the number of hours the plant is in operation, but after a careful consideration of the load factor.

Then it has to be decided how many days in the year the plant will be in operation. This number D will usually be about 300, allowing for Sundays and holidays, but in some cases it will be nearer 365, while in other cases plants will be shut down completely for a portion of the year.

The annual return on account of fuel saved may now be written : —

$$\frac{S\ U\ H\ D}{18{,}000{,}000}$$

For the common case of a plant working 10 hours per day for 300 days per year, this expression becomes : —

$$\frac{S\ U}{6{,}000}$$

For a plant working 24 hours per day for 300 days per year, the expression becomes : —

$$\frac{S\ U}{2{,}500}$$

The above expression reduces the fuel saving, usually the most important item, to an annual cash saving. The other items mentioned in an earlier paragraph can conveniently be reduced to the same basis and added or deducted to arrive at a net annual result.

The net annual saving has to be considered as compared with the investment required to bring it about.

To arrive at the total cost it is necessary to consider the following items : —

		Dep.	Annual charge.
1. Cost of machinery and appliance, including freight charges	$	%	$
2. Cost of erection	$	%	$
3. Cost of any extra equipment rendered necessary by installation of appliance	$	%	$
4. Cost of alterations to existing structures or equipment.	$	%	$
5. Cost of disturbance or extra expense during installation	$	%	$

In the form above suggested allowance is made for estimating a different rate of depreciation on the different items as may be desirable. In arriving at an allowance for depreciation besides the probable life of the apparatus or structure, other factors to be taken into account are the possibility of earlier abandonment due to changed conditions ; or supersession by later inventions or discoveries ; or in the ordinary course of development, an increased volume of business necessitating abandoning existing equipment and substituting other equipment on a larger scale. Taking all these facts into consideration a very frequent allowance for depreciation is 10 per cent.

The considerations indicated above can be reduced to a convenient form for analyzing the economy of any subsidiary apparatus somewhat as follows : —

Saving—

Fuel $\left(\frac{S\ U\ H\ D}{18{,}000{,}000}\right)$	$	
Water	$	
Other materials for operation	$	
Labor (if saving in materials handled results in saving of labor)	$	
Total saving		$

Charges—

Power expended in operation	$	
Materials for operation	$	
Labor for operation	$	
Materials for repairs	$	
Labor for repairs	$	
Annual value (if any) of space occupied	$	

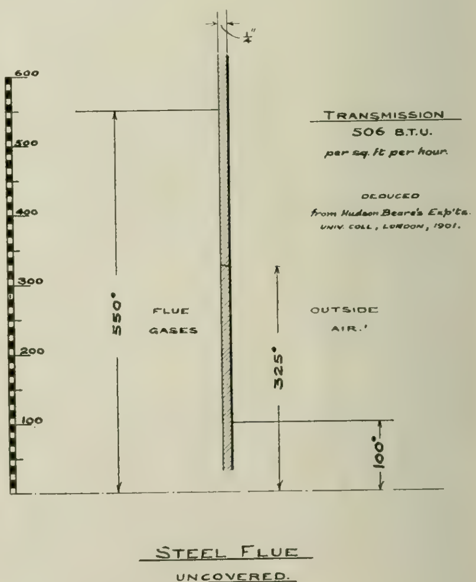
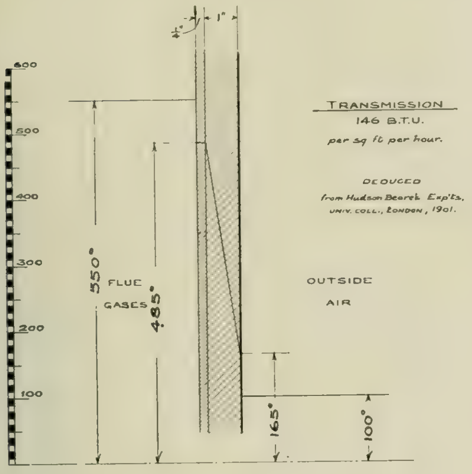


Fig. 6.

Cost of interruption of general operation due to operation or repairs	$	
Total charges		$
Net total saving		$

Depreciation charges as arrived at from table of installation cost	$
Net commercial economy	$
Total cost of installation as shown in table	$
Net commercial economy expressed as percentage of total cost of installation	%



STEEL FLUE
COVERED.
(ONE INCH MICA COVERING)

Fig. 7.

Having carefully gone into the details covered in the foregoing forms a clear-cut statement will be presented of a certain net result over and above depreciation charges, which may be expressed as a percentage return on the total investment. If that return is seen to be less than an ordinary bank interest, it is obviously better to let the amount of the investment so remain than to involve it in a commercial speculation. If the return is only slightly larger, the conclusion would usually be the same. But if the return is considerable the adoption of the appliance in question is justifiable, and is only a question of financing the necessary outlay.

Thus a net return of 15 per cent. or 5 per cent. over and above depreciation charges will hardly prove attractive. Viewed as a commercial risk, a return of 8 to 10 per cent. would be expected. This involves a gross return of 20 per cent. before any depreciation is allowed for, and this would seem a very reasonable figure to adopt as a limit which an economizing appliance must show before it can be considered economically desirable.

It is not to be expected that it will be possible in every case to completely analyze the situation from a purely financial standpoint. There will be, usually, elements in every problem that will baffle all attempts to reduce them to any such basis. Still the effort to do so will probably result in a much clearer grasp of the matter under consideration than if no particular system had been followed in considering it.

To discover the possible fields of economy in a steam plant, the best plan will be to examine and attack the various losses in sequence, completely analyzing the conditions as indicated in preceding paragraphs. Proceeding on this course the first source of waste specified is that due to the unconsumed fuel. This is not usually serious, and the only point is to reduce it to a minimum by a proper design of grate, taking into consideration the class of fuel to be burnt.

The next source of waste specified is that due to radiation and conduction; and this in its various forms is worthy of some consideration.

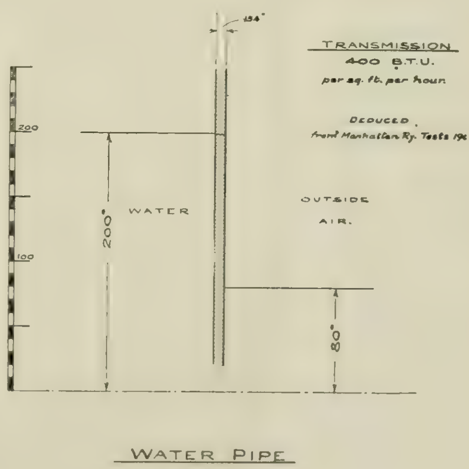
Radiation takes place from the exposed surfaces of the boiler, whether of metal or brickwork or other covering; from the surfaces of flue work; from piping and apparatus through which steam or hot water is conducted.

It is important to distinguish those surfaces in the case of which, if insulated to conserve the heat within, that heat, or a portion of it, may later be turned to use; and those from which the heat in any case ultimately goes to waste. As an example, if a pipe carrying hot water leads to a hot well from which the water is returned to the system the problem of saving all the heat possible is worth consideration; whereas, if that water has to be ultimately thrown away, the question whether it loses its heat by radiation in the pipe or later is of no moment, and there can be no possible object in going to expense to insulate the pipe.

A few remarks may be well interposed at this point on the general theory of transfer of heat by radiation and conduction. It may be pointed out that these two terms cover two entirely separate phenomena, which may be quite independent of one another. Radiation refers to the dissipation of heat through air or other substances, which takes place in the same way as light emanates from a source. The radiation does not necessarily affect the substance through which it is taking place: its effect is rather seen in the case of a substance which opposes an obstacle to the radiation. Conduction, on the other hand, refers to the actual transfer of heat from particles of a substance to adjacent particles, as where a bar of metal is heated at one end the heat is gradually disseminated until it reaches the other end. These two phenomena are usually so associated that for practical purposes it is most convenient to consider them as a single effect.

The problem, then, reduced to its simplest terms, becomes that of the transfer of heat from one fluid to another through an intervening solid wall—the term fluid being understood to include either a liquid or a gas. The steps in this transfer are five-fold, namely: (1) Conduction of the heat to the particles of the hot fluid in contact with the wall, (2) transfer of heat from those particles to the substance of the wall, (3) conduction through the substance of the wall, (4) transfer from the substance of the wall to the particles of the cold fluid in contact with the wall, and (5) conduction of the heat from those particles to the general body of the cold substance. This transfer can be well illustrated graphically. Fig. 3.

Let O X be a line passing through the wall in the direction in which the heat is passing. Let ordinates at different points represent the temperature existing at those points. A A' represents T, the temperature of the hot fluid. To cause a flow of heat to the particles next the wall a slight drop in temperature will be necessary, represented by A'B', so that B B' represents the temperature T' of the particles next the wall. To effect a transfer of heat from the fluid to the solid a difference in temperature is necessary, represented by B'C', so that the temperature of the wall next the hot fluid is represented by B C'. To maintain a flow of heat through the solid there will be a gradual fall of temperature from point to point, uniform if the substance is homogeneous, such as C'D'.



WATER PIPE
UNCOVERED

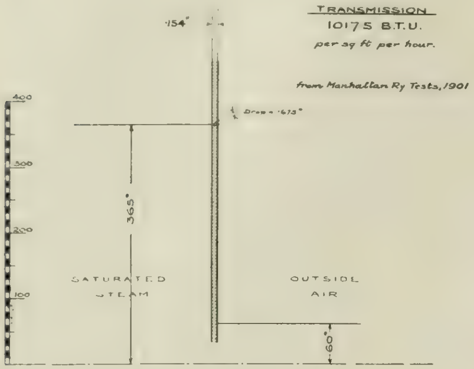
Fig. 8.

To effect the transfer from the solid to the cold fluid another difference of temperature D'E' will exist, so that the particles of fluid in contact with the solid will have a temperature t' represented by E E'. The remaining fall E'F' will cause the conduction of the heat through the cold fluid to the main body, which is at a temperature t represented by F F'.

The above is the general form of diagram for any case. The particular form depends on the substances forming the hot and cold fluids and the solid wall.

Some typical diagrams are shown, and the distinctive features will be briefly alluded to.

Certain general conclusions can be stated which these diagrams serve to illustrate. In each case it will be noticed that no account has been taken of any variation in temperature in either fluid, which assumption is fairly



STEAM PIPE
UNCOVERED.

Fig. 9.

justifiable in case there is considerable circulation in the fluids. In case there is not circulation, the calculated results may be affected to a large degree. This condition might, in fact, sometimes be introduced with good results in increasing the effect of insulation.

Where a hot fluid is in contact with a solid surface it is found that the transfer of heat is enormously greater for similar conditions of temperature when the fluid is a liquid than when it is a gas.

The rate of transfer is found to vary as the difference in temperature for ordinary ranges of temperature.

For solids in contact with a liquid, the solid will come almost to the same temperature as the liquid for a moderate flow of heat. When a gas is in contact, on the other hand, the difference in surface temperatures will be considerable.

When the solid is a metal with high conductivity the gradient to cause a flow of heat is very small and negligible in comparison with the other drops. From this it follows that within ordinary limits the thickness and conductivity of the metal are of secondary importance.

When the solid has a low conductivity, as in the case of brickwork or insulated covering of some sort, the drop through the solid becomes an important part of the whole temperature difference, and then the thickness and the conductivity become important factors in determining the heat transmitted under given terminal differences of temperature.

This is illustrated in the two diagrams of a furnace wall, Figures 4 and 5. In Fig. 5 the effect of thickening the wall is shown. The heat passing is proportional to the temperature drop between the outside surface of the wall and the air. This leads to the observation that in a general way the temperature of the surface exposed to the air indicates the perfectness of the insulation: the lower the temperature the less heat is passing out through that surface.

In the case of a steel flue uncovered, Fig. 6, the drop in temperature through the metal is negligible. Where the steel is covered with insulating material, as in Fig. 7, the drop through that material becomes an important part of the whole difference, and the heat transfer is in consequence much reduced.

Turning now to a case where the fluid in one case is water, as in Fig. 8, the diagram becomes of a different form. The drop from the water to the metal and that through the metal both become comparatively negligible, and the result is that practically the whole temperature difference acts to transfer the heat from the metal to the outside air. The transfer of heat in this case is much more rapid, nearly double what it would be if both fluids were gases at similar temperatures.

A somewhat similar case is that of saturated steam, illustrated in Figures 9 and 10. Although steam is of a gaseous nature, its tendency to condense when in the saturated condition seems to render the transfer of heat to a solid more akin to that found in the case of a liquid pure and simple.

A different condition is observed where the steam is superheated, as in Fig. 11. Here the heat transfer is that from a gas to another gas through an intervening wall, and may be expected to be only about half as rapid as in the case of saturated steam at the same temperature. This point is worth keeping in view when considering the advisability of using superheated steam.

Fig. 12 illustrates the condition in a condenser or feed water heater. Here the fluids on both sides of the wall are equivalent to water, and the surface differences on the two sides will be about equal. The total transfer will be very rapid, as a small temperature difference will result in a rapid passage of heat. The drop in the metal will also become comparatively important, and on this account the brass tubes usually employed for other reasons will also have the effect, owing to their high conductivity, of increasing the total transfer of heat.

It may be pointed out that one of the best means of heat insulation is the employment of a dead air space, such as is frequently done in lagging cylinders of engines. The reason for this is clearly shown in Fig. 13. Here the total temperature difference is divided into four parts on account of the four separate transfers between gas and metal. Further, there is a greater or less drop due to slow conduction through the intervening dead air. This would be very large if the air remained perfectly dead, but as it is practically impossible to prevent circulation in the dead air space, much heat is conveyed by convection, thus reducing the drop of temperature which would otherwise exist.

Turning first to the question of radiation and conduction from the boiler setting. It is probable that the total heat lost in this way from a well-built setting in good condition is from 3 to 5 per cent. of the total heat of coal burnt. It is suggested that these losses might be diminished by half, by the expedient of encasing the whole setting in a covering of light steel plate, leaving an air space at the sides and on top.

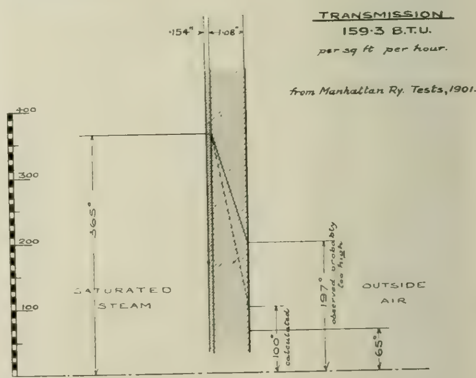
FLUE COVERINGS.

The question of lagging sheet steel flues will bear attention. Of course this would be only desirable where the heat of the gases is directed to an economizer or similar device. Even then the whole of the heat retained in the gases is not ultimately returned to the system, but only a portion, which may fairly be written down as .5.

Considering a flue temperature of 550 degrees, the heat lost by a square foot of unlagged flue surface will be about 450 B.T.U. per hour.

Taking as an example a covering of about 1 inch thickness of mica, the following table has been constructed. The figures are based on a unit of one square foot of surface :—

Material.	Cost.	B.T.U. retained per hour.	B.T.U. ultimately saved per hour. S	SU / 6000	%	SU / 2500	%
Mica 1" thick	15c. to 18c.	360	180	$.09	50	$.21	120



STEAM PIPE
COVERED

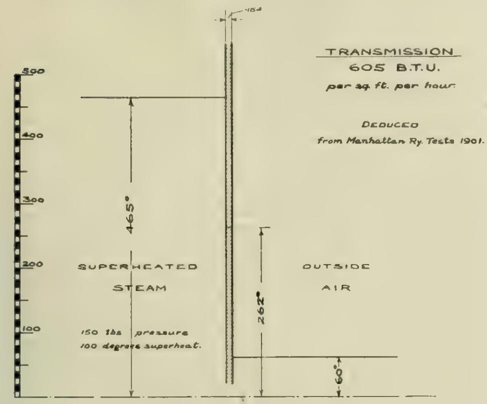
Fig. 10.

Other coverings that would suggest themselves would work out somewhat similarly as regards first cost and results attained. The general figures given above could be gone into more closely in detail for different substances if desired for comparative purposes.

PIPE COVERINGS.

Another point where losses from radiation take place is from steam and hot water pipes. These losses are much more important than those from flues, as the transfer of heat is so much more rapid.

Various tests have been made to ascertain the relative insulating efficiency of different substances. The result



STEAM PIPE
UNCOVERED
(SUPERHEATED STEAM)

Fig. 11.

may be summarized somewhat as follows: All the substances used for insulating covering have a low heat conductivity, and the differences between them are of secondary order. Some very complete tests were made by Mr. G. H. Barrus at the Manhattan Railway plant in 1901, and reported to the American Society of Mechanical Engineers at the May, 1902, meeting. The difference between the best and the worst insulator tested amounted to less than 5 per cent. of the heat which would be radiated from a bare pipe. It was figured that an annual loss of $1.61 per square foot per year for bare pipe would be reduced to 30 cents by the worst covering, and 22 cents by the best. From data given in that report the following table is compiled, showing the return on investment for the different styles of insulation, both for a ten-hour and a twenty-four-hour day, per year of 300 working days. Coal is taken as worth $3.00 per ton. It may be remarked that in each of the three series tabulated it is the cheapest covering which shows the largest percentage return :—

RETURNS ON INVESTMENT IN PIPE COVERING.

On basis of one square foot of surface.

Style of Covering.	First Cost.	S	Annual Saving, 10 hour day.		Annual Saving, 24 hour day.	
(2″ pipe : 80 lbs. press.)	$		$	%	$	%
Asbestocel	.22	612	.30	136	.72	327
New York Air cell	.26	606	.30	115	.72	277
Carey's Moulded	.20	601	.30	150	.72	360
Asbesto sponge moulded	.20	599	.30	150	.72	360
Gast's Air cell	.30	595	.30	130	.72	313
(2″ pipe : 150 lbs. press.)						
Asbestos sponge hair felt, 3 ply	.38	871	.435	114	1.04	274
Asbestos sponge hair felt, 2 ply	.32	863	.432	135	1.04	324
Asbestos sponge felt, 59 laminations	.37	863	.432	117	1.04	281
Asbestos sponge felt, 48 laminations	.37	850	.425	115	1.02	276
Magnesia	.40	850	.425	106	1.02	255
Asbestos, Navy brand	.35	828	.414	118	.99	283
(10″ pipe : 150 lbs. press.)						
Asbestos sponge felt, 76 laminations	.28	882	.441	157	1.06	379
Asbestos sponge felt, 66 laminations	.21	874	.437	208	1.05	500
Magnesia	.25	860	.430	172	1.03	412
Asbestos, Navy brand	.24	850	.425	177	1.02	425
Watson's Imperial : 1″ thick	.145	838	.419	289	1.01	696

A very evident loss of heat exists in the flue gases. It is possible to gather up this heat and return it to the system, and the only question is to what extent it is economical to carry this process.

FUEL ECONOMIZERS.

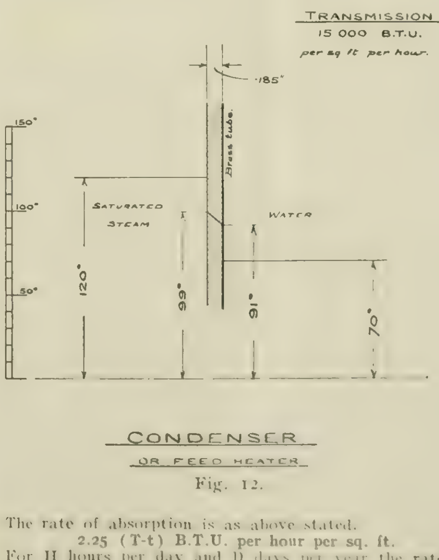
Of the means employed to utilize the heat of the flue gases, the most widely used is the Economizer, so named by its original inventor, Mr. Edward Green, when it came into general use in connection with steam plants about 1850. In this apparatus the heat is transferred from the hot gases through cast iron pipes to relatively cold feed water. In a sense the economizer is an extension of the boiler heating surface. It may be asked if the same purpose would not be achieved, and more simply, by extending the boiler heating surface proper, that is, by allowing more surface per unit of evaporation. This would not be the case for two reasons : firstly, the mean water temperature in a boiler is approximately the temperature of evaporation of steam, while in a separate economizer the mean temperature may be much lower, which causes a more rapid transfer of heat from gases at a given temperature ; secondly, the economizer heating surface is arranged to be automatically cleaned of the soot which tends to collect on it, which deposit would quickly result in diminishing the rapidity of heat transfer by 30 to 50 per cent. : further, the cost of economizer heating surface is, if anything, rather less than that of boiler heating surface, both being reduced to the same basis of unit heating surface.

The diagram for heat transfer through the tubes of an economizer is a particular case of the general diagram for heat transference already illustrated. The main drop of temperature is from the hot gases to the metal, the drop from metal to water being negligible. It is found that the unit of heat transference is about 2.25 B.T.U. per square foot per hour per degree difference of temperature between gases and water.

Using this value, with gases at temperature T and water at temperature t, the heat passed would be 2.25 (T-t). With water at steam temperature t_s, as in a boiler, and with the absorbing power of the surface reduced 1-3 by the deposit of soot upon it, the heat passed would be only 1.50 ($T-t_s$).

The difference between these two absorptions is $.75T + 1.50t_s - 2.25t$. This function increases with the increase of T, and hence for any flue temperature greater absorption is obtained by employing heating surface in the shape of an economizer. The limit is set, however, by the fact that there is only a limited range through which the water can be heated before it tends to become steam. Under average conditions the range of cooling of the gases in an economizer is about double the range of heating of the water, so that this puts a limit on the temperature at which the gases should be put into the economizer.

There is a lower limit of temperature below which it is not economical to attempt to cool the gases, which may be determined as follows :—



CONDENSER
OR FEED HEATER

Fig. 12.

The rate of absorption is as above stated.

2.25 (T-t) B.T.U. per hour per sq. ft.

For H hours per day and D days per year the rate of absorption is

2.25 (T-t) H D B.T.U. per year

This heat put into water or steam would be equivalent to the effect of burning

$$\frac{2.25\ (T-t)\ H\ D}{9000}\ \text{lbs. of coal.}$$

With coal at $3.00 per ton, this is equivalent to an annual saving of

$$\frac{2.25\ (T-t)\ H\ D}{6,000,000}\ \text{dollars.}$$

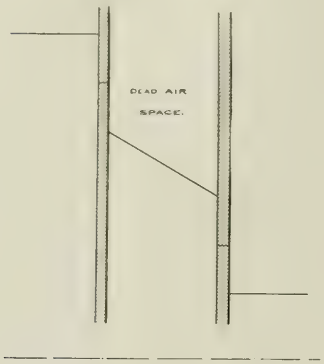


DIAGRAM OF HEAT TRANSMISSION THROUGH DEAD AIR SPACE.

Fig. 13.

The first cost of one square foot of economizer heating surface will be in the older parts of Canada about $1.25 per sq. foot complete. Assuming that to justify its installation, this must show a gross return of 20 per cent. the above expression

$$\frac{2.25\ (T-t)\ H\ D}{6,000,000}\ \text{must be equal to or greater than \$ .25}$$

$$\therefore T-t = \frac{1,500,000}{2.25} = \frac{666,666}{H\ D}$$

For a 10-hour day and 300 days per year this becomes $T-t = 222$ degrees.

For a 24-hour day and 300 days per year this becomes $T-t = 93$ degrees.

Proceeding on these lines a table can be constructed showing the economical limit of temperature of gases in the economizer and in the boiler for different entering temperatures of the feed water.

TABLE.

Steam at 100 lbs. pressure.
Coal assumed worth $3.00 per ton.
For plant running 10 hours per day 300 days per year.

Temp. of Feed.	Range of Temp. to heat feed to 310°.	Range of Temp. of cooling of Gases.	Economical limit of Temp. of Gases in Economiser.	Economical limit of Temp. of Gases in Boiler.
80	230	460	302	762
120	190	380	342	722
160	150	300	382	682
200	110	220	422	642
For plant running 24 hours per day 300 days per year.				
80	230	460	173	633
120	190	380	213	593
160	150	300	253	553
200	110	220	293	513

The question is sometimes asked: what is the proper size of economizer for a set of boilers of given capacity? There is no single definite answer to such a question, as the answer depends on a number of factors. The question is, however, capable of investigation for any individual case in which the factors are known. The course of such investigation will be briefly indicated.

Avoiding refinements, a general formula which will give fairly approximately the range of heating of the water in an economizer under average conditions is as follows:

$$x = \frac{2.25\ (T_1 - t_1)}{\frac{W}{N} + 3.4}$$

t_1 is the initial temperature of the water (Fahr.).
x is the rise in temperature of the water (Fahr.).
T_1 is the temperature (Fahr.) of the gases coming from the boiler to the economizer.
W is the amount of water passed through the economizer in pounds per hour.
N is the number of square feet of heating surface in the economizer.

From the above formula it is possible to derive another showing the size of economizer commercially economical in a given case.

The heat units saved per hour may be expressed

$$\frac{2.25\ W\ (T_1 - t_1)}{\frac{W}{N} + 3.4}$$

This saving has an annual value of

$$\frac{W\ U\ H\ D\ (T_1 - t_1)}{8,000,000\left(\frac{W}{N} - 3.4\right)}$$

the symbols U, H and D having the same significance as before.

The initial cost of the economizer being taken as $1.25 per square foot, or 1.25 N dollars in all, the gross saving in order to equal 20 per cent. of this must have a value of at least .25 N.

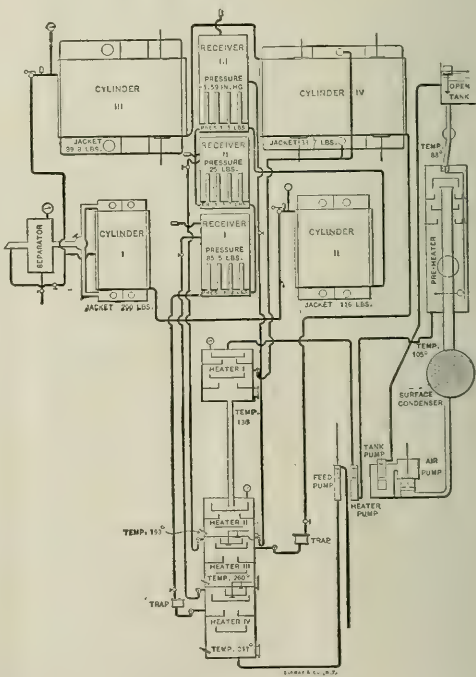
$$\text{Whence}\ \frac{W\ U\ H\ D\ (T_1 - t_1)}{8,000,000\left(\frac{W}{N} + 3.4\right)} = .25N.$$

$$\text{Or}\ N = W\ \frac{U\ H\ D\ (T_1 - t_1) - 2,000,000}{6,800,000}.$$

As an instance, consider a plant of 1000 boiler h. p. capacity (A S M E rating) equivalent to an hourly evaporation of 30,000 lbs.

Suppose the plant is in operation 10 hours per day for 300 days in the year, coal being worth $3.00 per ton.

$U = 3$
$H = 10$
$D = 300$



STEAM CONNECTIONS, HOT WATER RETURNS AND HEATERS

Fig. 14.

Suppose the initial temperature of the gases is found to be 500 degrees, and the water is heated before coming to the economizer to a temperature of 150 degrees,

$$T_1 - t_1 = 350.$$

$$\text{Then}\ N = 30,000 \times \frac{3 \times 10 \times 300 \times 350 - 2,000,000}{6,800,000}$$

$= 5074$ square feet.

This is a ratio of about 1 square foot of economizer to 6 lbs. of water evaporated per hour, which is about the ratio usually adopted in Canadian practice.

This expression becomes a little more complicated where, as frequently happens, the rate of evaporation in a plant varies considerably at different periods of the day. The procedure then would be to divide the day into periods during which the evaporation could be taken as constant and arrive at the value of each expression separately; finally making a summation of all such expressions.

$$\frac{W\ U\ H\ D\ (T_1 - t_1)}{3{,}000{,}000\left(\frac{W}{N} - 3.4\right)}$$

Where boilers are banked when not needed, and the remaining boilers run at full capacity, the temperature of the gases T_1 will remain approximately constant. In any instance where this is the case, the total summation may be arrived at by making H the equivalent number of hours per day during which the plant would need to run at full capacity to give the same total output of power.

Consider as a typical case an electric light or power plant of a maximum capacity of 1,000 Boiler H. P. Suppose this maximum H. P. is only called for during 3 hours per day, and that during 12 hours of the day the load is only 25 per cent of the maximum; the plant being shut down during the remaining 9 hours.

The twelve hours at 1-4 load would be equivalent to 3 hours at full load, which, with the 3 hours actually at full load, would make an equivalent of 6 hours run per day at full load. Such a plant would probably be in operation 365 days in the year.

Assuming the same values of U, T_1 and t_1 as in the preceding example, the heating surface of the economizer would be

$$N = 30{,}000 \times \frac{3 \times 6 \times 365 \times 350 - 2{,}000{,}000}{6{,}800{,}000}$$

$$= 1{,}321 \text{ square feet.}$$

This, it will be noticed, is only about 25 per cent. of that found desirable in the previous case.

Speaking generally, it will be found that an economical allowance of heating surface will be about one square foot to every six pounds of water evaporated per hour, reckoned on the average evaporation throughout the day.

The maximum capacity of an economizer is in practice limited by the consideration that it has to afford sufficient flue area to pass the amount of flue gases evolved during the period of maximum evaporation. With economizers of standard construction this limit is reached at an evaporation of from 36,000 to 50,000 lbs. per hour, under natural draft conditions. In a plant not exceeding this capacity, a single economizer can be installed which will catch all the heat available under any conditions of load.

With larger plants either one of two courses can be taken. If not too large the plant can be equipped with a single economizer, into which all the boilers will discharge their flue gases, and which at average load will afford ample flue area. Then at maximum load the flue area can be increased, at some sacrifice of efficiency, by opening a by-pass damper as much as may be necessary.

The alternative is to provide the economizer heating surface in units corresponding to certain sections of the boiler equipment. This arrangement has the disadvantage that when any section of boilers is banked down the corresponding economizer is idle. This difficulty would best be met by nominating a certain section of the boiler plant as that to carry the constant load, and equipping that section with economizers and any other economizing apparatus considered desirable. This section would naturally be chosen in the most convenient location as regards coal and ash handling and so forth. The other sections of the plant which would only be called upon for occasional service need not be burdened with fixed charges in the way of subsidiary apparatus unless it could be shown that the increased economy of operation would more than offset those fixed charges.

Such an arrangement would be desirable from another point of view. The part of the plant in constant service would be naturally subject to more rapid deterioration than that in only occasional use. When the constant service plant became unfit for further service the other sections would be still in a fairly good state of preservation. The problem of replacement would thus be rendered simpler than where the whole plant would be in a half worn out state.

With the exercise of forethought in design, the sections for occasional service might be arranged so that they could at any time be provided with the additional apparatus, if the demands for power should necessitate a larger proportion of the plant being called into constant service.

AIR HEATER.

Another method of taking up and utilizing the heat in the flue gases is by means of an air heater which heats the air going to the furnace for combustion; or it may be that the air when heated is used for other purposes.

These heaters have been used with considerable success. As compared with an economizer they have the disadvantage that the transfer of heat from gas to gas through metal is only about half as rapid as from gas to water, for equal differences of temperature. On the other hand, the temperature difference may easily be greater, as the feed water is usually heated by other means to a point considerably above atmospheric temperature. Again, as most of the air heaters in use are constructed, there is no provision for automatically cleaning the surface exposed to the hot gases, and the collection of soot is bound to deteriorate the transmitting power of the surface. On the other hand, it appears to be the case that the use of hotter air for combustion in a furnace leads to more perfect combustion, and in this way the beneficial result is greater than that due alone to the amount of heat returned to the system. It is worth while to note the theoretical saving in fuel due to preheating the air for combustion. This is shown in the following table,

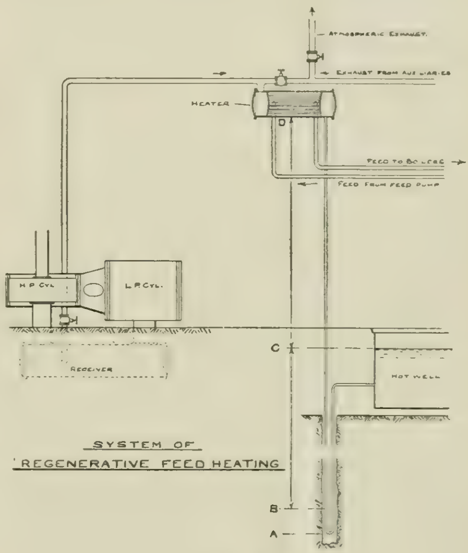


Fig. 15.

which shows the number of degrees the air must be heated to correspond to a 1 per cent. saving for different quantities of air per lb. of coal burnt, the coal being assumed of a calorific value of 13,000 B.T.U. per pound.

Lbs. of air	18	20	22	25	28	30	35	40
Degrees rise of temp....	30.5	27.5	25	22	19.5	18.5	15.7	13.7

FEED HEATERS.

This term is generally used to designate those heaters which take the heat of steam, usually exhaust steam, and apply it to the feed water. Feed heaters are of two classes, known as the open and closed types, which are analogous to jet and surface condensers. In the open type heater the steam passes into and is condensed in the water to be heated. This is the simplest type of heater. Practically all that it consists of is the outside shell, as the water itself forms the cooling surface. The main objection to the type is that the oil from the condensed steam gets into the feed water. In some types of open heaters quite elaborate filtering arrangements are provided to overcome this difficulty. The closed type of heater is free from this objection, as the condensed steam is kept entirely separate from the feed water and is run away to waste. The transfer of heat from saturated steam to water is very rapid, so only a small amount of heating surface is necessary, but it should be of brass, like condenser tubes. A most important point structurally is that there should be freedom of expansion of the different parts; otherwise strains are set up which tend to loosen the joints and start leaks.

It is the practice sometimes to place what is known as a primary heater on the exhaust line of a main engine on

the cylinder side of the condenser. A heater so placed must be a closed heater, and virtually forms the first section of the condenser, from which the cooling water, instead of being run to waste, is used for feed purposes. Many engineers regard the risk of leakage as sufficient of a drawback to condemn this arrangement. Any leakage is difficult to detect and inconvenient to make good.

An arrangement which is sometimes adopted is to place the heater on a branch from the main exhaust line. Then all the steam does not pass by the cooling surface, but the steam space in the heater is kept filled with steam by what is drawn in to take the place of that condensed. The action of the surface is probably not quite as effective as in the former case, but this can be easily made up if necessary by the provision of a little more surface. The condensation can be taken care of by draining back to the main exhaust line through a small pipe. Arranged in this way the heater gets all the steam it needs for heating the water passed through it, and at the same time it can be very readily isolated from the main exhaust without interfering at all with the latter.

The above refers to a heater in connection with a condensing engine. The water can be heated by this means to a temperature a few degrees below the temperature corresponding to the exhaust pressure.

With a non-condensing engine the same arrangement can be applied and the water heated nearly to 212 degrees. In this case an open heater can be used, if desired, either on a branch from the main exhaust, or with an exhaust head to carry off the excess steam that is not condensed in heating the water.

With a condensing plant, a further heating of the feed is usually achieved by means of what is known as a secondary heater. This is a heater which takes exhaust steam from the various auxiliary engines of the main plant or such of them as are run non-condensing.

This leads up to the question of the best way to arrange auxiliary engines; whether they should be highly economical condensing engines, or whether, on the other hand, economy of steam is no object, provided the heat of the exhaust is returned to the system.

Probably the best way to get a light on this problem is to analyze a concrete case. In connection with a large plant using, say, 30,000 lbs. of steam per hour, or 1,000 Boiler H.P., A.S.M.E. rating, capable of developing 2,000 Engine H.P., consider a small auxiliary whose actual output is one H.P. The main engine generates its power with an expenditure of 15 lbs. of steam per H.P. per hour. If it is an electric generating plant, the method of obtaining the 1 H.P. required with least expenditure of steam will be to use a small motor taking current from the main generator. Assuming a combined efficiency from main engine to small motor of 75 per cent., the actual steam consumption for the 1 H.P. will be 20 lbs. per hour. If the feed is taken at a hot well temperature of 100 degrees, and the steam pressure is 150 lbs. per square inch, the actual expenditure of heat in heat units would be 20 x 1125 = 22,500 B.T.U.

Now, as an alternative, consider the 1 H.P. to be developed by means of a separate non-condensing engine with an expenditure of, say, 40 lbs. of steam per hour, the exhaust, however, being utilized in a heater. The heat units supplied to the steam used are in this case 40 x 1125 = 45,000 B.T.U. But of this heat, after 2545 B.T.U. have been transformed into mechanical work, the balance or 42,455 B.T.U. is returned to the system. There would be a small deduction for the amount of heat lost by radiation and leakage in the small engine and connections, probably making the net expenditure of heat up to 3,200 B.T.U. Although the consumption of steam is greater than with the electric motor auxiliary, the net cost of operation is seen to be very much less, in heat supplied from the ultimate source of heat, the furnace.

Instead of the auxiliary engine using 40 lbs. of steam, a very wasteful engine using, say, 150 lbs. per hour, may be used. In this case the same amount of heat would be transformed into work, the balance being rejected in the form of heat, and returned to the system, with the exception of that lost by radiation and leakage, which would probably be somewhat greater than that lost in the case of the more economical engine.

These examples lead to certain general conclusions. There is greater ultimate economy in operating a small engine, provided the exhaust is returned to the system, than in obtaining the same amount of power by means of a direct drive or its equivalent from a main engine which is run condensing, when no heat is returned to the system. But such auxiliary engines should be in themselves as economical as reasonably possible. The process of using more steam than is necessary for the sake of having more exhaust to heat with is akin to heating with live steam. Such a process is neutral as regards economy, and is subject to inevitable losses of greater or less magnitude due to radiation and similar effects.

It has been shown that there is economy in using the exhaust from an economical non-condensing engine, and this statement is true so long as there is feed water below the temperature of exhaust of that engine, which can be heated. Further consideration will show that this principle is as applicable to the main engine as to the auxiliary, and that there would be theoretical economy in making the main engine partially non-condensing, so as to afford sufficient steam to heat the feed up to the temperature of exhaust steam at atmospheric pressure. Proceeding on the same lines of reasoning, there is no apparent reason why the economy of this process should reach its limit at the temperature of steam at atmospheric pressure, and the general principle can be established that there would be theoretical economy in drawing off a proportion of the steam at every stage of the expansion, sufficient to heat the feed water up to the corresponding temperature. This scheme has been carried into effect in the case of some pumping engines by Mr. B. V. Nordberg, of Milwaukee. (Fig. 14.) Steam is drawn off from each of the receivers of a quadruple expansion engine sufficient to heat up the feed by successive stages up to the temperature of the first receiver. The steam condensed at each stage is trapped and the condensation also returned to the feed. The arrangement can be shown to be in accordance with true principles of thermodynamic economy.

Careful tests of a pump at Wildwood, near Pittsburgh, equipped with heaters on the Nordberg system, showed that an economy of about 10 per cent. was achieved with the heaters in operation as compared with the results shown by the same engine without the heater system in use.

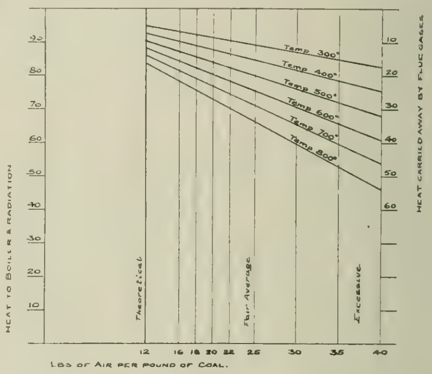


DIAGRAM OF LOSS OF HEAT IN FLUE GASES

Fig. 16.

Whether or under what circumstances the somewhat elaborate scheme adopted by Mr. Nordberg would be economically desirable would be too large a question to discuss here.

It is suggested that with an ordinary type of compound engine, in which the receiver pressure is usually a few pounds above atmospheric pressure, an arrangement on the lines of that shown diagrammatically (Fig. 15) would be simple, being free from mechanical devices such as traps, and would be inexpensive in cost of installation, and ought on that account to show an acceptable degree of commercial economy. The device consists broadly of a connection led from the receiver through a closed heater to the hot well. As the pressure in receiver would be somewhat above atmospheric, the pipe would need to be led downwards to a point A, so that the maximum pressure ever attained in the receiver would not depress the level of the condensed water below A, the height AC being made greater than the water head BC corresponding to the maximum receiver pressure. Thus a water seal would be always maintained to check any escape of steam. In addition, the heater should be elevated above the water level of hot well sufficiently so that the water head CD would be greater than the greatest fall of pressure below atmospheric in the receiver due to variation in the load on the engine. This would provide a safeguard against any water being drawn over into the receiver. The heater placed in this way would automatically draw off as much steam as is required to heat the water to its own temperature: beyond that point there would be no tendency to condense, and therefore no tendency to draw away more steam.

With such a system the auxiliaries, such as the feed pumps, would be arranged to exhaust through the same

heater at receiver pressure, thus utilizing their exhaust and doing away with any additional heaters.

COMBUSTION OF FUEL.

One of the most important elements in the economical operation of a steam plant is that of the combustion of the fuel on the grates. It has been pointed out times without number how much heat is wasted in the products of combustion, always containing more or less excess of air, which leave the boiler at a temperature several hundred degrees above that of the atmosphere. At the risk of reiterating an oft-told tale a table is appended showing the amount for various amounts of excess air. For purposes of illustration the gases are taken as escaping from the boiler at a temperature of 500 degrees Fahr., which is about the condition usually found in boilers working at a moderate capacity. The loss is expressed as a fraction of the total heat developed by coal containing 13,000 B.T.U. per pound.

The corresponding loss is given in the case of gases which are passed through an economizer of normal capacity, and escape therefrom at a temperature of 300 degrees.

The results are shown graphically in a diagram which gives a more comprehensive general idea of their extent. (Fig. 16.)

Lbs. of air, theoretical.	12	16	18	20	22	25	30	35	40
Loss Gases at 500	.104	.136	.152	.168	.184	.209	.251	.289	.329
Loss Gases at 300	.057	.074	.083	.092	.100	.114	.135	.157	.179

For theoretical combustion, as in a Bomb calorimeter, the oxygen contained in 12 lbs. of air is sufficient for the complete combustion of a pound of coal. The combustion on a boiler grate is a different matter however. Here time is an important element, and time cannot be allowed to permit each particle of oxygen to find a particle of carbon or hydrogen with which to combine. The result is that many particles of oxygen pass through without finding available particles of carbon with which to combine, and the air of which those particles of oxygen form a part constitutes the excess air. It will readily be seen that in the interests of economy it is desirable to keep down the excess to as small limits as possible.

It is possible by making a simple analysis of the flue gases to determine the percentage by volume of carbon-di-oxide contained therein as the result of combustion. From this determination the amount of air taken per pound of coal can be deduced very closely by the formula

$$G = \frac{K}{\%CO_2}$$

Where K = 227 for Anthracite coal, 5% ash.
K = 203 " " " 15% ash.
K = 218 " Bituminous " 5% ash.
K = 196 " " " 15% ash.

The foregoing, though a fairly simple matter for scientific experiment, is too cumbersome for everyday practical use.

A very ingenious piece of apparatus, known as the econometer, has been devised to afford a continuous indication and, if desired, a continuous record of the amount of carbon-di-oxide in the flue gases. As, however, the fundamental element of this apparatus is a very sensitive balance, it is easy to understand that it usually does not long remain in good working order under the adverse conditions of an ordinary boiler room. Some typical records are reproduced in Figs. 17 and 18 through the courtesy of Mr. H. G. Stott, of New York.

Still, while it may be rather difficult to obtain an exact numerical record of the results achieved in the way of keeping down the excess air, it is always possible to keep a watch that the conditions of the fire are such as to tend to the desired result. This, it may safely be asserted, is rather a question of skill in operation than of design of the grate or furnace; and attention to this point constitutes an important difference between good and indifferent firing.

HAND AND MECHANICAL FIRING.

The principal reason why attention is required is because in the process of combustion of solid fuel on a grate, if bad conditions arise in any way, their tendency is to go from bad to worse, not to readjust themselves. Thus, if one spot in a fire is thinner than the average, that point affords an easier passage for air and more rapid combustion takes place at that point, and the thin spot tends to become thinner. It is, of course, a fundamental condition to obtain good combustion that no air should enter the combustion chamber except through the bed of fuel. If the grate is imperfectly covered with fuel this condition is not met, and air will enter at the bare places on the grate. It more frequently happens that the grate, though not actually bare, is at certain points only covered with ash, the residue of fuel previously burnt. Any air which enters at such a point only adds to the amount of excess air, as it does not take part in any combustion. Air passing through incombustible matter soon reduces its temperature, with no combustion going on to keep the temperature up, and any spots on the grate covered only with ashes can be detected by their dullness compared with the rest of the fire. Such a condition is watched for by a good fireman, and corrected either by throwing on fresh coal or by distributing the coal already on the grate.

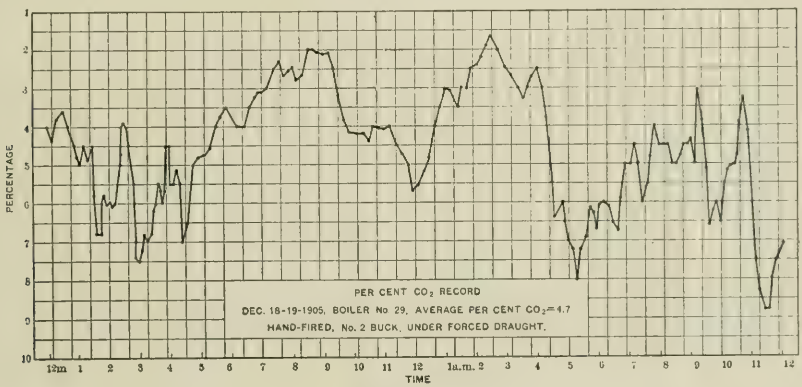


Fig. 17.

These irregularities in the combustion constitute one of the principal difficulties in any system of mechanical stoking. No matter how well designed and adjusted the mechanism is, irregularities will occur, and unless some personal manipulation is applied to counteract them, the results attained will fall short of the ideal.

It is probable that the mechanical stoking of a fire is one of the most difficult operations that is attempted. With the best of mechanical stoking there is room and need for occasional manual interposition. It is a matter of frequent comment that a test made by the makers of some automatic stoker gives results considerably in excess of those found in regular operation. This is not to be wondered at when it is remembered that the machine is in the hands of those who have given it careful study, and whose natural aim is to give it every possible assistance. With equally assiduous attention it would do the same good work at any time.

One of the most obvious objections to hand firing, and one which the use of a mechanical stoker obviates, is the necessity of having the firing door open from 5 to 10 per cent. of the time. This difficulty has been met with good results by arranging that the opening of the fire door closes the uptake damper of the boiler.

Another recognized source of loss in firing is in the escape of unconsumed hydro-carbons. When bituminous coal is fired on a flat grate, it has to be first heated to the temperature at which combustion will take place. As the temperature of the newly-fired coal rises, the lighter and then the heavier hydro-carbons are volatilized

Some of these come off before the temperature is reached at which combustion will take place. The radiant heat of the fire is temporarily blanketted off by the new coal, and so combustion of those hydro-carbons is not started in the furnace chamber. As soon as these gases come in contact with the comparatively cool surface of the boiler they are considerably cooled, and all chance of combustion is at an end. This condition is improved by surrounding the furnace chamber with brickwork, so that the gases have to pass through a chamber with incandescent sides and top before reaching the boiler surface. This is the object sought in the grate in a Dutch oven, which practically forms a reverberatory furnace. The same object is achieved to a less degree by the arch provided in the furnace of the Stirling boiler. The principle is that the brickwork is placed in such a position that it is subjected to the extreme temperature of the furnace: this same fact constitutes a drawback, as the condition is very destructive to the brickwork, and usually necessitates its renewal at frequent intervals. The same principle is seen in the formation of the furnace chamber in the Heine type of boiler, and in the Scotch setting of the Babcock & Wilcox boiler, in both of which a check of firebrick laid on the lowest row of tubes delays the contact of the products of combustion with the boiler surface. Other more elaborate methods of providing for the complete combustion of the volatile hydro-carbons are those of the underfeed stoker, in which the new coal is pushed in under that already burning, so that the hydro-carbons have to pass out through the hot fire; and of the down draft furnace, in which the same effect is produced by carrying the draft downward through the grate. In the the matter, which is too frequently referred to to require any particular comment here.

Another circumstance which complicates the action of combustion is the presence in the fuel of impurities, such as sulphur and iron. The effect of these substances is to cause the ash, instead of being left in a dry divided state, to form in a fusible mass, which solidifies as soon as its temperature drops somewhat, forming what is known as clinker. This is obviously very difficult to deal with by any mechanical method that can be devised. The formation of clinker at any point on a grate has the effect of stopping the flow of air through the grate at that point, which leaves the metal subject only to the heating influence of the fire, and leads to deterioration or deformation of the parts of the grate. With any form of grate, but more particularly in one which contains certain elements of mechanism, the deterioration of parts has to be recognized as an important factor, and one which cannot be overlooked in making up a general statement of results.

DRAFT—NATURAL AND MECHANICAL.

An important problem in connection with the combustion is that of the means to supply air for combustion, that is the draft. This is about the most difficult problem in the design of a steam generating plant. There are so many uncertain and very variable factors entering into the problem, and, furthermore, there is an unfortunate absence of any really reliable data on the subject, so that really scientific treatment of the problem is almost out of the question. The usual method of approaching it is one of

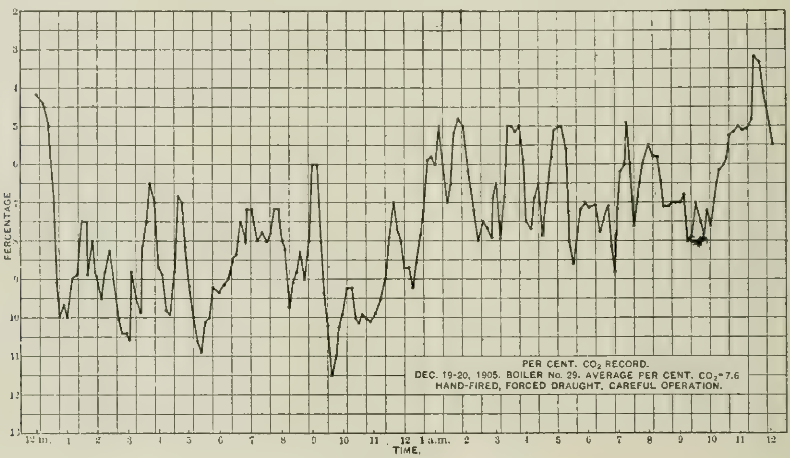


Fig. 18.

latter case the grate is subject to the maximum temperature resulting from combustion, and special provision has to be made for this in the way of water-cooled grate bars. In the case of an ordinary up draft the effect of the cold air passing in through the grate acts to preserve the material to a large extent from the effects of the high temperature.

With ordinary hand-fired grates the methods employed to prevent the loss due to unconsumed hydro-carbons are those known as alternate firing and coking firing. Alternate firing, as the term implies, refers to firing alternately on the two sides of the grate, so that there is always a portion of the fire with an incandescent surface, uncovered with fresh coal, to radiate heat into the furnace and assist in starting the combustion of the hydro-carbons. Coking firing consists in heaping the fresh coal in the front of the fire instead of spreading it, so that the volatile hydro-carbons have to pass over the incandescent fire at the back; after the volatile gases have passed off, the second part of the process is to distribute the resulting coke over the whole surface of the fire. This appears to give very perfect combustion, but it has the disadvantage of being very hard on the fireman, involving him in a good deal of exposure to the heat of the fire.

Closely allied to the question of unburnt hydro-carbons is that of smoke. Merely viewed as a question of economy, this is by no means so serious as is generally supposed. The actual amount of carbon lost in the shape of smoke is a fraction of one per cent. It is apt to be an indication, however, of other losses in the way of incomplete combustion. Then there is the aesthetic aspect of rule of thumb, based as far as possible on experience under fairly similar conditions.

The fundamental principle involved is that to cause a flow of air through a duct or flue, or through the interstices of a bed of coal, a difference of pressure has to be set up in some way, and the air will flow from the region of higher pressure to that of lower.

The most important point at which a difference of pressure is necessary is at the grate.

The points which affect the flow of air through a grate are:—

(1) The difference of pressure. The flow theoretically varies as the square root of this difference.

(2) The kind of coal. This has a large bearing on the flow. The small anthracites offer far more resistance than the larger sizes. Bituminous coal becomes puffed up and porous as the volatile gases are driven off, and then offers a comparatively easy passage to the air.

(3) The thickness of the bed of coal. Obviously, the thicker the bed of coal, the greater will be the resistance to the passage of air. The resistance would be expected to vary as the thickness.

(4) The amount of ash and clinker in the fire.

The amount of coal burnt per square foot of grate surfaces depends on:—

(1) The flow of air.

(2) The amount of air per pound of coal.

In some careful experiments it was found that with a draft pressure of .21 inch of water, and taking about 20 pounds of air per pound of coal, 19 pounds of a good semi-bituminous coal was burnt per square foot of grate

Moderately thick fires of about 6 inches were carried. If this condition could be reproduced, the consumption of coal per square foot of grate would be governed by the formula :—

$$C_f = \frac{\sqrt{d_g}}{\sqrt{.21}} \times 19 = 41.4\sqrt{d_g}.$$

† Where C_f is the coal burnt per square foot of grate and d_g is he draft pressure at the grate in inches of water gauge.

As the amount of air in average cases would probably be nearer 25 lbs. per pound of coal, a safer expression would be

$$C_f = 36\sqrt{d_g}.$$

Such a formula would need to have a different constant for each class of coal.

Were it possible by means of such a formula to find the actual draft necessary at the grate, it would still be necessary to determine the additional draft necessary to convey the air through the ducts, boiler tubes, flues and economizer, if any, in order to determine the total draft pressure that it would be necessary to set up to operate the system. These resistances would be of a widely variable character. To cover them it would be well to figure on providing double the draft necessary at the grate. Corresponding then to the above expression, the expression for the total draft necessary would be

$$d_t = 2\frac{C_f^2}{1296} = \frac{C_f^2}{648},$$

This expression would indicate a total draft pressure equivalent to .35 inch of water to produce combustion at the rate of 15 lbs. of coal per sq. foot of grate per hour, which is an average rate. For most coals, however, rather more draft than this would be desirable, say .5 to .6 inches water gauge.

In designing the draft producing arrangements, two things which have to be kept in view are the possibility of having to burn inferior coal, and a provision for overload. To cover both these contingencies a margin should be allowed.

When under certain conditions the draft available is not sufficient to cause as rapid combustion as is desired, the combustion can be hastened by carrying a lighter fire, or, what comes to much the same thing, by breaking up the fire so as to allow an easier passage for the air. It will easily be understood that either of these courses, though creasing the capacity of a grate, it apt to do so at the cost of reduced efficiency. In general combustion is more efficient the more a fire can be left alone. A thin fire, it is evident, more rapidly develops irregularities than one with a thick body of coal, so that, generally speaking, a fairly thick fire is more conducive to economy.

DIAGRAM OF DRAFT PRESSURES
NATURAL DRAFT.

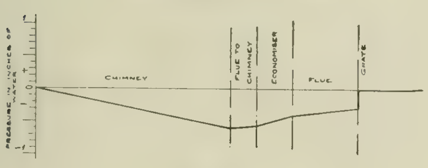


Fig. 19.

This constitutes the main cause of difference in efficiency between a chimney and a system of mechanical draft. Where sufficient draft is available to burn the coal at the rate desired without disturbing the fire by breaking it up, or too frequently repairing irregularities, there can be no material difference in the efficiency of operation, however the draft is produced. For certain conditions, such as the combustion of the smallest sizes of anthracite, sufficient draft could hardly be obtained with a chimney without making it of undue height. In such a case mechanical draft is obviously desirable.

The question between a chimney and a mechanical system then for the ordinary case comes down to one of cost.

A chimney is necessarily an expensive structure in first cost, and its cost increases rapidly with any increase in height, approximately as the square of the height. On the other hand, a chimney, once built, entails no expense for running or, if properly built, for maintenance. Its depreciation, based on its life of service, may be taken at a very low figure.

A fan, on the other hand, is comparatively low in first cost. Being a piece of moving mechanism, and usually involving motion at pretty high velocities, a fairly liberal depreciation should be allowed, say 10 per cent. There is a further item of expense in the power required for operation. This forming a small auxiliary to the plant should be arranged so that the heat of exhaust steam would be utilized : in this way the actual cost of operation would be reduced within small limits.

The appended table shows estimate of the comparative charges on a chimney and mechanical draft systems, for a plant of 1,000 Boiler H.P. :—

Items.	Brick Chimney 150' x 6'	Single Ind. Draft Fan 8' x 4' with short stack and connections Engine.	Duplicate Ind. Draft Fans 8' x 4' with short stack and connections. Two Engines.	Single Forced Draft Fan 6' x 42" and duct Engine.
Cost of installation complete	$4,500	$1,250	$2,300	$900
Depreciation allowed—per cent.	3	10	10	10
Power expended in operation		12 H.P.	12 H.P	7 H.P.
Cost in B.T.U. per hour (exhaust utilized)		60,000	60,000	35,000
Equivalent coal in 300 days of 10 hours	none	20,000	20,000	11,667
Equivalent coal in 300 days of 24 hours	none	48,000	48,000	28,000
Estimated labor in attendance—hours. (300 days of 10 hours)	none	150	200	150
Ditto. .... (300 days of 24 hours)	none	300	400	300
Annual charges 10-hour day	$	$	$	$
Coal at $3.00		30.00	30.00	17.50
Water at 10c.M... ...		15.00	15.00	9.00
Oil, waste, etc.... ...		5.00	5.00	5.00
Labor for operation		37.50	50.00	37.50
Depreciation	135.00	125.00	230.00	90.00
Interest at 6 p.c....	270.00	75.00	138.00	54.00
Total	$405.00	$287.50	$468.00	$213.00
Annual charges 24-hour day.				
Coal at $3.00		30.00	30.00	17.50
Water at 10c. per M.		35.00	35.00	20.00
Oil, waste, etc.		10.00	10.00	10.00
Labor for operation		75.00	100.00	75.00
Depreciation	135.00	125.00	230.00	90.00
Interest at 6 p.c....	270.00	75.00	138.00	54.00
Total	$405.00	$392.00	$585.00	$291.00

With direct driven or electrically driven fans the items for fuel for power would be four or five times as great.

It will be noted that either a forced or induced draft can be provided at considerably less charge than a chimney. It should be noted that these single-fan arrangements provide no standby in case of a breakdown in any of the machinery. This involves the risk of a shutdown, which may easily be the cause of greater loss and inconvenience than the difference in annual charges. The duplicate plant, either forced or induced draft, provides an insurance against this, but it will be noted that the estimated cost becomes as great as that of a chimney.

For a permanent steam plant with a fairly steady load, the general conclusion is that a chimney is the best means of producing draft.

This general conclusion may be modified by special circumstances.

If the permanence of the plant is a matter of doubt, it will not be safe to reckon on as low a figure for depreciation as 3 per cent. A higher estimate than this would soon run the fixed charges up well above those of mechanical draft, and make mechanical draft appear a better proposition for such a case.

When a plant is called upon for an occasional output of power much above the average, to provide a large chimney to meet the occasional emergency would involve the sinking of a large extra amount of capital. The best way to meet such a case will usually be to provide a chimney sufficient to carry the average load, with auxiliary mechanical draft to assist with the emergency load. As between forced and induced draft in such a case, there are several points in favor of forced draft.

A forced draft fan is more readily isolated when not in use. When an induced draft fan is not in use, either the gases have to be passed through the idle fan, or a complicated bypass has to be provided.

Forced draft requires less power to handle a given amount of air, since the temperature is lower.

The forced draft fan does its work under more favorable conditions of temperature.

With forced draft the furnace chamber is more nearly at the atmospheric pressure, and there is consequently less tendency for leakage of cold air into the boiler setting,

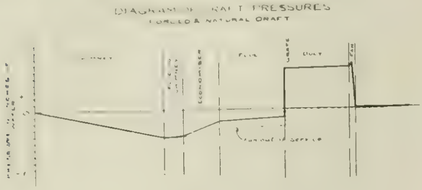


Fig. 20.

and the absorption of heat is more efficient. This point will be more clearly understood by an examination of the diagrams, Figs. 19, 20 and 21, showing the distribution of the draft pressures throughout the system from the intake to the forced draft fan or ash pit to the chimney.

It is important to notice that with any forced draft arrangement it is desirable to so arrange that there shall always be a slight suction above the grate. This obviates the necessity of shutting off the pressure when opening the firing doors. Also it obviates the leakage of heated gases from the boiler setting, which involves loss of heat and also contaminates the air of the boiler-room.

Where it is impossible to provide a moderate chimney sufficient to attain this end, induced draft is the preferable scheme.

In conclusion, it cannot be too strongly impressed that economy of operation is dependent upon two things, equipment and operation. Without the equipment it is unjust to expect of an operating engineer the highest results in the way of economy; and unless backed up by efficiency

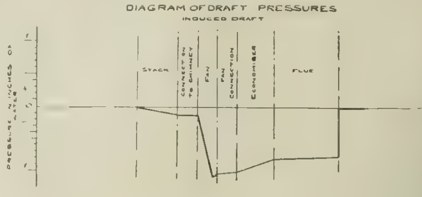


Fig. 21.

in operation, the most careful designs of equipment will be unproductive of best results. As an instance of this, a forcible case which came recently to notice was that of an engineer who insisted, as a part of his contract to design and instal a plant, that the operation of the plant should be left in his hands for the term of one year, so that there should be no chance of his design being condemned through improper handling in operation. It is suggested that it would frequently be an instructive study to apply to the simplest operations of upkeep the methods of analysis suggested for more elaborate schemes of improvement, and it would usually be found that the results obtainable would be remunerative out of all proportion to the cost of achieving them.

SOME LEGAL PROPOSITIONS OF INTEREST TO ELECTRICAL MEN.

BY ROBERT McKAY

It is not possible to separate out any particular branch of law as being that in which electrical engineers are more especially interested, there being, either in England or in this country, no special law relating to electricity, and it follows that, to attempt to cover the field of law in which electrical engineers may be said to be interested, would be to undertake a general disposition upon the entire field of law. The common law of England, as modified by equity, is the source of all the law in force both in the United States and in Canada, and, indeed, still constitutes the great body of the law in those countries. This, at the time its fundamental principles were established, naturally took no cognizance of electricity, for the very obvious reason that electricity was then entirely unknown. Notwithstanding the fact that the use of electricity has been a very modern development, reaching its commercial importance only in the latter half of the last century, the principles of law settled centuries before were settled upon such broad lines, based upon the fundamental principles of human action, that they have, speaking generally, been found quite adequate to provide for and deal with the various questions, rights and obligations arising out of the modern uses of electricity. So far as its general principles are concerned, the interest of electrical men in them is the same as the interest of the rest of the public. They are governed by them in the same way as men in all other walks of mercantile and commercial life. With these general principles I do not propose to in any way deal, but there are some matters of special interest to electrical men with which I purpose to deal, premising by saying that I cannot pretend to exhaust all the various matters which might be deemed of special interest to them.

1. The rights, duties, and liabilities in connection with and arising from the stringing of wires.

The great progress of electricity is largely due to the fact that by this means power for various purposes can be transmitted to considerable distances by means of wires. These, prior to the last ten years, have generally been aerial wires, principally strung on poles. The stringing of these wires has given rise, and will give rise, to problems which the electrical engineer has to consider in making his plans, and in the construction work under his supervision.

At the outset we are confronted with the elementary principle of English law as to the ownership of property. Practically all the land in the country is held by private individuals or corporations or by the Crown in fee, and the result of that ownership is that an individual or a corporation owning a piece of property has the right not only to the surface but theoretically downwards to the centre of the earth and upwards to the limits of the atmosphere, and that right is exclusive unless under special circumstances not necessary to be here referred to. Any person, therefore, starting to run a wire from one point to another is met with the difficulty that as soon as he leaves the limit of his own property he is a trespasser. The moment he carries his wire, no matter at what height, over the land of an individual, or, for that matter, over a public highway which is vested in a municipal corporation, he subjects himself to an action for injunction, and for damages. It is at once obvious that if there were no amelioration of that strict rule of law the stringing of wires for electrical purposes, while not perhaps a physical impossibility, would be a commercial impossibility. As soon as the commercial benefit of the telegraph was recognized, modification of the law as above stated was made by statute in England, the United States, and in Canada, these generally proceeding in the direction of giving the telegraph companies statutory rights to erect their poles and string their wires along the existing highways.

So far as Canada is concerned, the legislation is to be found in the Electrical Telegraph Companies Act, the provisions of which, briefly, are that any electrical telegraph company, duly incorporated, has the right to construct its lines of telegraph along and upon any of the public roads and highways, and across or under any of the navigable waters, by the erection of necessary fixtures, including posts, piers or abutments, for the purpose of sustaining its wires or cables, provided these shall be so constructed as to not incommode the public user of such highways, or impede free access to any buildings in the vicinity, or to interrupt the navigation of the waters. The legislation in regard to this is very simple, and has given rise to no difficulties of importance, and has enabled the telegraph companies which have commenced operations to give an efficient public service. It need only be observed in passing that the telegraph companies, as such, have no rights of expropriation of private property, and, therefore, if circumstances should arise, such a telegraph company required to bring its lines across private property, it would

be driven to bargaining with the owner thereof, and if it could not come to an agreement there is no machinery providing for its enforcing the right to cross. This has not, so far as I have been able to find, given rise to any practical difficulty in any decided case, and in view of the systems of survey in force in Canada, and the way in which the settled part of the country is intersected by highways, it is not likely that any important practical difficulty should arise, at least which could not be easily surmounted by taking the wire a slightly circuitous route.

Following the telegraph came the telephone. The telephone was in contemplation at least at the time the Electrical Telegraph Act, as it appears in the Revised Statutes of Canada, was passed, as is shown by the fact that there is an exception made in the concluding portion of that act, making it expressly not applicable to telephone. At the time of the original introduction of the telephone to the commercial world, as is well known, the invention was covered by patents held by the Bell Telephone Company, and the legislation in respect of telephones in the first instance necessarily took the form of private legislation, incorporating and giving privileges to the "Bell Company." The original Act of the Dominion of Canada, incorporating and giving statutory powers to the Bell Telephone Company, was very broad in its terms. It gave to the Bell Telephone Company very wide rights over all the highways in the Dominion. These rights in respect of the highways, as they have been construed by the courts, in some instances override the jurisdiction of the municipalities over the highways, to this extent at least that upon the law as now finally decided by the Privy Council, the court of last resort, the municipalities cannot prevent the occupation or use by the Bell Telephone Company of any highway. They have a jurisdiction to direct the manner in which the work shall be done, so as to provide for the public safety, but this power of control is in the nature of police control, and would not extend to the preventing of the use of the highway. This was determined in the case of the City of Toronto v. Bell Telephone Company, in which a very large number of questions arose. The result of the case is rather of academic interest to electrical men at present, unless those connected with the Bell Telephone Company, as it is in the last degree improbable that any other company will ever secure quite the same rights and privileges as those granted by the Bell Telephone Company's Act. One point may perhaps be of some general interest. That arose from the fact that the Bell Telephone Company, in addition to its Dominion Act, obtained, shortly after the passing of the Dominion Act, a special Act from the Legislature of the Province of Ontario, in which the privileges were not so broadly expressed as in the original Act. It was contended on behalf of the City of Toronto that, by taking the Act from the Local Legislature in the form in which it was taken, the company had waived, in this Province at least, the right to insist upon and use the charter rights given by the Dominion Act. This contention, as would have been expected by a lawyer, did not prevail, it being held in effect that the Acts were simply cumulative, and the company might exercise all or any of the powers that it could find in either or both Acts. What chiefly interests electrical engineers at present is what the position of any telephone company, or proposed telephone company, would be in reference to this matter. Before that position could be stated, it becomes necessary to consider under what authority, and in what way, companies might obtain incorporation, and it might be well even with electrical engineers, to clear up loose ideas which one occasionally finds prevalent as to the rights which incorporation gives. Some people seem to think that if you can get a company incorporated with the power as expressed in the charter to string wires you can proceed to run your wires anywhere, and that you thereby get some certain right or authority from the Government to go over highways or private property. That is an erroneous conception. To illustrate the procedure in the Province of Ontario, any five men can apply for and obtain incorporation as a telephone company, having it expressed in their charter that they have the right to operate, maintain and instal telephone services, with the necessary wires and appurtenances, etc. That charter in itself so granted gives the company no right whatever upon a public highway, or to cross private property, or to expropriate private property. In order that you should have the right to run upon any highways under such charter as that, you have to get permission from the municipality in which you purpose running a wire. This power has to be granted by by-law, and in the present state of public opinion you may rest assured you will get no such power, unless you are prepared to make a satisfactory bargain with the municipality. I might add that, in this Province, a municipality cannot grant an exclusive right to a telephone company for longer than five years. In the same way a company incorporated for purposes of light, heat and power being incorporated in the same manner can obtain power from any municipality, by by-law, to use the streets or highways for the purpose of conducting electricity thereon, but that is again, in the same manner as the telephone companies, subject to the agreement made with the municipality, and to the by-law of the Council passed in pursuance of the agreement. If it became necessary, for the purpose of supplying the municipality, to exercise certain limited rights of expropriation of private property for right of way, etc., within a limit of 10 miles from the municipality which had granted the by-law, that power can be obtained under the Act Respecting Companies for supplying Municipalities with Light, Heat and Power.

What precedes states generally all the power of the nature referred to which can be obtained without special legislation in favor of the particular company, and in the result, as will be seen, any considerable project, such as transmission of Niagara power to the city of Toronto by a private company, involves the obtaining of special legislation. The existing companies all have such legislation, and, from the companies' standpoint, a reasonable satisfactory kind, granting them all the powers that are necessary to enable them to completely carry out their project. The question is often asked, when the principles as above stated as to stringing of wires over private property are under discussion, how it is that more particularly throughout cities and crowded municipalities you find telephone wires and lines crossing your property, even attached to your house, and over your roof, and so on; and the enquiry is made, how can those things be, consistently, with the principles enunciated? The answer is that the wires are there practically because they have been permitted to be there. In legal view, any telephone or telegraph company which strings a wire across any private property is a trespasser, and liable for damages. Further, the owner, if he wished to himself abate the nuisance, is entitled to cut and remove the wire. Fortunately there is not much trouble so far from occurrences like that, although the writer has in mind one prominent building in the centre of the city which had so much trouble with wires on its roof that they threatened to remove them all, but in the end an arrangement was arrived at, a scaffold being erected, and the wires attached thereto. The existing condition in many places is an illustration of the reasonableness of the average man in matters affecting the general interest. A good illustration of the legal position is given by the fact that the telephone companies, even the Bell Telephone Company, with its wide-reaching powers, is not entitled to cut trees on private property for the purpose of giving passage for its wires, even if the portion of the tree cut is overhanging the highway. Not alone so, but they are not entitled to cut the trees on a highway adjoining a man's land, as is illustrated by a well-known case of Judge Hodgins v. Bell Telephone Company, and a number of similar cases have arisen in different American States, and also a case in Manitoba, with similar result.

Having so far dealt with the theory of property, the rights in regard to wires, we come now to another question which interests electrical men, remarking that we will have to return, at a later period, to another aspect of the question of statutory authority. In electrical work, telegraph and telephone companies are dealing with currents of low voltage, not likely to do damage either to person or property, but with the introduction of electric light, with its powerful currents on the wires, and the more recent introduction of the power lines, with their currents of still higher voltage, new difficulties and dangers to person or property arose, and numerous illustrations of the legal results are already to be found in our law reports. Most of these difficulties, so far as their legal aspect is concerned, fall within that branch of law known as the law of negligence, the cases arising on account of injury to person or property either from wires of high voltage causing injury directly to person or property, or causing injury through the crossing of other wires. In connection with this latter matter, the courts show a tendency to lay down legal principles which to a certain extent may be looked upon as hard upon the electrical man. In the first place, so far as crossing of wires is concerned, the principles first enunciated are to be borne in mind. If the wire has been placed in an unauthorized position, the company placing same and maintaining same is a trespasser, and if the wire should become charged with dangerous current, and do injury, the company would probably find itself liable for all the damages which might follow. If the wire was in its position legally, either on account of having obtained permission from the property owner to string the wire, or on account of having a statutory authority to maintain the wire where it was, then the liability depends upon whether or not, in the stringing of the wire and in its maintenance, reasonable caution had been taken to prevent accident occurring, and to prevent injury to person or property.

Definitions of negligence, as of most other matters in law, differ somewhat, but the commonly accepted definition is a very general one, and one which would commend itself to common sense, viz.: "Negligence is the doing of

something which a reasonable man would not do, or the neglecting to do something which a reasonable man would do, whereby damage has been caused to the person or property of another." That being the legal proposition, the application of it to the generation and conducting of electricity is the matter for consideration, and in this regard the courts have established principles that a very high degree of care is required in such matters. Indeed, they put the electrical company in the position of a man who, having brought into existence something that is highly dangerous to life or property, is under the obligation to see that it is thoroughly protected, that no injury to person or property results therefrom, that the man who brings such dangerous substances into existence at any particular place is under obligation to see that it is so confined that it does not escape in such a manner as to do injury. One learned judge used the illustration of a man taking a Bengal tiger down the street, stating it would be admitted by everyone that a man who would undertake so to do would be held strictly responsible for its being so secured that it should not injure any other person, and he compares the electrical man dealing with the current of high voltage to the man with the tiger. For instance, in a case which occurred recently in the Province of Quebec, an electric light bulb installed in a man's house in some way became charged with a high current, and he, putting his hand thereon, was killed. The company was held responsible therefor. Another case showing the obligations arising from the stringing of wires, and the crossing of various wires, one in which the writer happened to be connected: the case of Hartford v. Bell Telephone Company. In that case an electrical despatch company, which at the time maintained a watchman's service, and which had no statutory right to use the highways for the purpose of stringing wires, maintained a wire running from their office, close to Yonge street in the city of Toronto, west to Niagara street, running the wire from house to house. They attached their wire to a gable end of the Toronto Silver Plate Company's factory, situated about one hundred feet east of Portland street. From there a very long span without intervening pole or support to the west side of Portland street, where it was attached without permission, it was alleged, to a Bell Telephone Company's pole. From there it proceeded westward in the direction of some cottages, which were erected in the rear of some stores and houses on King street, being fastened to one of the cottages, and there passing to the end of a house, continuing on its western course. The Toronto Electric Light Company ran some wires on Portland street, passing below this wire. The Bell Telephone Company, altering their wires, loosened this despatch wire to some extent. According to the evidence, some boys up in a tree in the area west of Portland street previously referred to, chopped down a branch which fell across the despatch company's wire, and, loosening it from its fastening, it fell across the electric light company's wire. When the current was turned on in the light wire, the insulation was broken down at the point of contact, and the despatch company's wire, becoming charged, set fire to the cottage to which it was attached. Immediately upon the cry of "Fire" being raised, Mrs. Hartford, who lived in one of the cottages, running out, came in contact with the despatch company's wire, which was on the ground, and suffered very severe injuries. Action was brought against the Bell Telephone Company, the Toronto Electric Light Company, and the Holmes Electric Despatch Company, and considerable contest arose to fix the responsibility. The Bell Telephone Company were dismissed from the action. They were held to be free from liability, that they not having maintained the wire, and its affixing to their pole having been without their permission. The Toronto Electric Light Company was sought to be made liable on the ground that their wire should have been so insulated that no current could escape from it, and that they should maintain the insulation so that any wire coming in contact with it could not become charged with current. There were several experts called on behalf of the plaintiff, who affirmed upon oath that it was easily possible to so insulate electric light wires, and that not only was it possible to do so, but that it was the only proper course. In the result in the particular case the plaintiff failed, for the court finally held that there was no negligence on the part either of the Holmes Company or the Toronto Electric Light Company, the accident being caused entirely by the act of the boys, and the remedy, if any, was only against those young gentlemen, which, of course, was worthless.

It would not be possible, within the limits of this paper, to lay before you all the cases which have arisen upon this subject, but perhaps one or two of the more recent ones may be of interest. One, in Chatham, where the workmen of the Chatham Gas Company, which operates electric light, were straightening a pole to which a guy wire was attached, cut the guy wire, allowing it to hang loose, and leaving it in that way. Either by the action of themselves, or by the action of some third party (it was not shown which), the guy wire was thrown across a power wire so as to become a live wire, and the plaintiff, coming in contact therewith, was injured. The gas company was held responsible, the court saying that even if the wire were thrown across the power wire by some passerby, the company that left the wire hanging loose in that fashion was responsible for all the mischief which might ensue.

The last mentioned cases are cases in which members of the public not connected with the electric company are concerned. The same broad principle of taking the greatest possible care to prevent the electric current doing injury applies to workmen of the company, and is a matter for very earnest consideration to the electrical engineer for very obvious reasons. In the first place, upon the principles of common humanity one should take the greatest possible care to avoid injury to the life or person of any workman in his employment or connected with him in employment. Secondly, the entirely selfish consideration that his own safety may be imperilled has to be considered; and, thirdly, the prevention of financial loss to the company, through damage actions arising from negligence, is a matter to be guarded against, from a purely commercial standpoint. A few cases will illustrate this. In the much-litigated case of Randall v. Ottawa Electric Company, Messrs. Ahearn & Soper had, for the purpose of illuminating certain buildings on the occasion of the visit of the Prince of Wales, strung wires on an existing telegraph pole belonging to either the Great North Western Company or the Bell Telephone Company, the wire being some distance below the other wires on the pole, fastened to glass insulators by tie wire, the ends of which were not insulated. The plaintiff, who was in the employ of the Ottawa Electric Company, was engaged in putting up for that company, on the same pole, apparently without any particular license or authority from the owners, an electrical transformer for the purpose of transmission of lighting power to adjacent premises. While working on the pole, the plaintiff's hands came in contact with one of the ends of the tie wire, which, not being insulated, became a live wire. The plaintiff received a shock, fell to the ground, and was injured. It was at first held in the Court of Appeal that there was no duty on the part of the defendants towards this plaintiff, who was not their employee, and that in any case the plaintiff was guilty of contributory negligence in not wearing rubber gloves, and taking every precaution in handling wires which he should have known might be live wires. This judgment was reversed in the Supreme Court, and the case sent back for new trial. The laws laid down by the Supreme Court illustrate the high degree of care necessary in insulating and otherwise, so far as possible, protecting wires carrying dangerous current.

Another case, which illustrates perhaps as well as any the very high degree of care necessary, is the case of Griffith v. the Cataract Power Company. In the station of the Cataract Company at Decew Falls, near St. Catharines, there were two generators of very high voltage. Two men were working cutting a trench in the concrete flooring of an alley-way in the power house. The alley-way was crossed at right angles by others, and on each side were electric machines and live wires within an arm's length of anyone working in the trench. There was a slat nailed across a cross-alley, notwithstanding which one of the laborers went into this, and was sweeping towards the trench the litter which was scattered about, when he suddenly received an electric shock, and became unconscious. The other man went to help him, and was killed by the shock, bodies of both men being found near the switchboard. It was shown that there was a rupture in the insulation of a loop of the cable hanging from the switchboard, directly over where the man was lying, and the question came up as to the sufficiency of the insulation. The company was held liable. The language used in this case, and in another case in the Supreme Court of the Province of Quebec, seems to put the law about as tersely as it can well be put, referring to a company operating dangerous electric currents. "Persons dealing with dangerous things should be obliged to take the utmost care to prevent injuries caused by their use, by adopting all known devices to that end." And again: "In all occupations attended with great and unusual danger, there must be used all appliances readily obtainable, known to science, for the prevention of accidents."

The engineer himself is naturally and properly, to a certain extent, an exception from the rules applicable to other employees. The decisions on this point, as one might expect, illustrate the doctrine of contributory negligence in the case of a man who, from his position, should know and appreciate his responsibility for taking care of himself. In one case, a man employed as manager of a company to put a plant in good repair had worked in the place for three weeks or more. Then he did precisely what the householder did in the case referred to above—took hold of an electric bulb, and received a shock which killed

him. His widow was held disentitled to recover, for it being held it was his duty to put the lights in repair, and knowing he was dealing with dangerous appliances, and possibly some of them out of order, he should not have put himself in the way of danger.

The next proposition is one of very considerable importance to electrical engineers, and one which perhaps is rather less familiar than most of those previously dealt with. It connects directly with the matter of statutory right dealt with in reference to stringing wires, dealt with in an earlier portion of the paper. Briefly stated, it is this : That whenever a company has statutory powers, whether the authority of an Act of Parliament of the Dominion of Canada throughout the Dominion in a matter within its jurisdiction, or by Ontario legislation in this Province, to do a particular act which it is doing, or maintain the particular works operated by it, that is to say, has rights by statute to construct and operate these works, it is not responsible in damages for the necessary consequences which follow the doing of the work which it has been authorized to do. The word "necessary" must be emphasized in that sentence, because the co-relative principle is that the company is responsible for damages for any injury which might possibly have been avoided in the doing of its works by the use of the most modern appliances and methods known to it to avoid injury. Then follows the proposition that, having made their works in the best and most careful manner possible, the obligation arises to maintain them in efficient condition, and if damage arises from neglect so to do, again liability arises. It is not possible, within the limits of this paper, to fully illustrate the scope of these principles. A few brief illustrations must suffice. The first case of note arose in England in 1893, in the case of the National Telephone Company v. Baker. It was a very thoroughly considered case. The National Telephone Company, in the particular municipality in question, had their system in operation for a number of years, and they were using the well-known telephone construction with grounded wires. The defendant obtained statutory authority to construct a tramway and run it by electricity, using a trolley system, putting up their wires, and so operating the railway. When they began operations the telephone company found its service utterly inefficient, because of currents used in connection with the trolley system affecting their wires. They brought action to stop the defendants from operating their tramway, or, at any rate, to lay upon them the expense of converting their existing telephone system with the grounded wire to the metallic circuit. The telephone company failed. The holding was that the tram company, having statutory authority to construct their tramway and operate it in the way they did, were not liable for damages. In other words, the Legislature having given the tram company the authority they had done, and they having confined their operations within the limits of the authority, the telephone company were in the same position as the man who feels himself aggrieved by having a railway run in front of or in proximity to his property. He simply has to put up with that injury.

Other cases might be cited illustrating the same principle, but the statement of law in the last case is very clear and definite. Very similar questions have arisen in some of the American States, and the same result arrived at. For instance, in a case between the Cincinnati Telegraph Company and the Cincinnati Railway. The telephone company having been earlier in date by ten years could not restrain the operation of the trolley or the interference by the trolley current with their circuits. The auxiliary principle that it is only such damage as is the necessary consequence, for which they are relieved of responsibility, and that they are responsible for any damage which can be avoided, is perhaps best illustrated by the vibration cases, of which there are quite a number—one in England, Shelfer v. City of London Lighting Company ; another in Montreal, Garreau v. Montreal Light, Heat & Power Company ; and another in Hamilton, Hopkins v. Canada Power & Light Company. In each of these cases the company had authority to construct a power house and operate it. In each case they did so. In the Shelfer case they discharged steam, and also caused injury by vibration. In the Garreau and in the Hamilton cases injury to the adjoining property was caused by vibration. In all cases the company were held liable, it being held that while they had the power under their statute to construct the works, the works might have been so constructed as not to cause this vibration, and the construction of the works not being compulsory upon the company, they were liable in each case for the damages to the property of the respective plaintiffs.

The last case along this line to which I desire to refer is a very recent one, decided by the Privy Council in England, being the South African Cable & Telegraph Company v. the Capetown Electric Tramway Company. It is interesting as perhaps forecasting decisions upon the questions, the arising of which has been looked for for some time, viz., upon whom the responsibility for damages by electrolysis to water pipes, etc., arises. In the particular case the cable company ran through Capetown Bay on its way to England. The Capetown Tramway Company operated a tramway upon the trolley system. The current from the electrical tramway in some way found its way into the water, and thus into the sheathing of the cable. It apparently did not attack the cable at all, but the result of the operation of the current was to so interfere with the cable that it was absolutely useless for the transmission of messages. The Telegraph & Cable Company brought action, which, having gone to the highest courts in the colony, found its way to the Privy Council. The ultimate result was that the telegraph company failed, it being held, under the same principle as that enunciated in the National v. Baker and several cases previously mentioned, that they were not responsible in this way to the service of the cable company, they having statutory authority to run their tramway and operate it with the devices with which it was operated, the cable company must be left to protect their own cable by such devices as they might be able to use.

Space forbids the extended consideration of the principles upon which these decisions proceed. The effect of them from a practical standpoint is apt to be viewed differently by different individuals, dependent very largely as the lawyers find such things do, upon the nature of the personal interests of the party concerned. There is always the balancing of the apparent wrong or injustice done to the party whose existing system is interfered with against greater public interest which cannot permit of an existing company, for any purpose, being able to fence off a whole territory or centre of activity entirely for itself on account of the fact that the operations of other concerns may tend to interfere with its operations, particularly where dealing with such an elusive matter as electricity. It is now perhaps scarcely of interest in the branch of law with which perhaps commercial men are most frequently concerned in everyday life, viz., the law of contract. There are practically no matters which are of special concern to electrical men any more than to men engaged in other branches of commercial activity, and it may be said that the general experience of legal men is that commercial men generally have a pretty general knowledge of its principles.

There are perhaps the old questions, from an electrical standpoint, of the effect of telegraph messages or telephone communications as constituting a contract. Sufficient to briefly state that a contract may be just as effectually made by telegram as by any other way, provided there is an explicit agreement upon the subject matter of the contract. The original message is, of course, the proper evidence of it. A contract in any matter that can legally be a subject of oral bargain can be just as well made over the telephone as by personal interview ; the only practical difficulty that arises in case of dispute is to prove the identity of the person talking ; that is the same question of proving the fact, and it does not affect the binding nature of the contract if the fact be proved, although prudence suggests the confirmation of any contract made over the telephone in any matter of importance by letter.

On the question as to the responsibility of a telegraph company for failure to transmit a message, this is one which under the law in this country arises entirely between the sender of the telegram and the company. There is no contract with the receiver of the telegram, or intended receiver, and the receiver is not entitled to sue a company for either failure to transmit a message or improperly transmit a message. There is only one other observation, a very trite one, but one which can hardly ever be said to be quite useless, viz., that in the making of contracts embodied in writing, the important matter for the engineer is the part which falls to his lot, the preparation of the specifications and of the contract. If he is in any way responsible therefor, he must bear in mind, first, last, and all the time, that it is what is in writing and the plain meaning of the writing, as it will be read by a judge or a third party, that counts, and that he is entitled to the enforcement of. It is at this point that the lawyer refers to the desirability of consulting your solicitor upon such matters, good advice under all circumstances, even if coming from an interested source, but that advice is subject to modification. In the first place, a business man or concern has to frame its own contracts. If a lawyer is to be consulted in every turn of a commercial business, a considerable number of members of that profession would soon form a necessary part of the staff of every considerable concern.

Business men nowadays have to be capable of themselves clearly expressing their own contracts, and the lawyer, even when consulted, has his limitations, sometimes very sharply defined. He must be dependent upon his client and upon the engineer for exact instructions, not only as to what is desired but as in many instances to the form in which it must be expressed, and speaking generally specifications and the technical part of a contract require

more care at the hands of an engineer when a lawyer is engaged than at other times. Where a lawyer and engineer are employed, their collaboration ought to produce a properly-framed contract. "In the multitude of counsellors there is wisdom." Unfortunately there is another adage which sometimes has to be borne in mind: "Too many cooks spoil the broth." Of the desirability of clear expression and the avoiding of ambiguity nothing need be said, but the difficulty not infrequently arises from accepting wording suggested, for instance, by a selling agent or by the other party to the contract, with an explanation which he gives of the meaning of it, or what he understands thereby, or with a statement of what he intends to do under it. These statements and explanations are of no value whatever. They cannot, as a rule, even be given in evidence if question arises. It is what is written, and only what is written, that is considered in the dealing with a written contract.

As a last matter, which is of interest purely to Ontario men, I desire for a few moments to refer to the operation of what are known as the Conmee clauses of the Municipal Act, principally by reason of the misapprehensions that exist in many quarters in regard to the Act and its scope and effect. This has perhaps arisen in many instances by reason of the construction placed upon the Act, and the campaign directed against it by some newspapers in the larger cities, principally those of the city of Toronto. Whether such arises from a feeling of hostility to the man whose name it bears, or otherwise, I cannot say. It may be of some assistance to deal briefly with the origin of the Act. It did not at all originate at the instance of the electrical companies. The situation very briefly is this: A large number of electrical plants, chiefly for lighting purposes, had been installed in various municipalities throughout the Province at a time when no municipality had any right to engage in the supplying of electric light or power. With the development of the municipal ownership idea these municipalities, as is not infrequently the case with municipalities and others looking at business conducted by other people, thought that they were being charged too highly by the companies, and that the companies were making a good thing out of them, which in many instances was perhaps not a correct view of the existing facts. But they began to agitate for the passing of an act giving the municipalities power to build electrical plants. Then the electrical companies, seeing their business threatened, opposed the granting of these powers. It was thought that justice to the existing companies demanded that where, as in many places, plants had been put in on the faith of contracts with the municipality, and in the expectation of being able to supply the public lighting service, and as, in many instances, the owners of those plants paid taxes to considerable extent, that it would not be fair to allow the municipality to take public money, including the taxes of the electric light owners, to establish a plant in competition with them, and consequently these clauses were finally passed in the form in which they appeared in the amendment known as the Conmee Act, which subsequently was consolidated into the Municipal Act. The clauses are distinctly and definitely enabling clauses. They give the municipalities the right, which they previously had not, to themselves construct gas, electric light or water works. Then the Act proceeds to make it a condition that where there is an existing gas, electric light or water works company for or in a municipality, the municipality cannot itself establish a plant without first having offered to buy out the existing plant at a price which the municipality first named. If the existing company does not see fit to accept the offer they may appoint an arbitrator, and the price is then determined by three arbitrators appointed as provided by the general arbitration clauses of the Act, or, in certain instances, by the official municipal arbitrator. After the arbitration has been held, the municipality may either accept the amount fixed by arbitration, pay the price, and acquire the plant, or they may decline so to do, the only consequence of that event being that they have to pay the costs of the arbitration. If the owners go into the arbitration, they are obliged to sell at the price. If, however, they do not want to part with their plant, they simply pay no attention to the municipality's first notice, decline to appoint an arbitrator, and then the municipality is at liberty to go on and establish its own plant. There was at one time some difference of opinion as to this last matter, as to whether or not a company could be compelled, under the clauses of the Act, to sell. This appears to be now well settled in accordance with what is above stated, that the company are not by the Act compellable to part with their property, and this is one of the grave complaints made against the operation of the Act. So far from the provisions of the Act as to arbitration and the method in which the price is to be ascertained are concerned being the subject of complaint at the instance of the municipalities, it should fairly be subject of complaint at the instance of the companies.

In ordinary expropriation matters it is a fixed rule of law that a person desiring to expropriate must pay the very highest price. Mr. Hayes, president of the Grand Trunk Railway, has referred to the right of railway expropriation in a satirical way as "the right to pay double what anybody else would be called upon to pay." In the Conmee Act the provisions for the preventing anything of the kind resulting to the municipality are very wide and sweeping. They provide that all depreciation must be allowed for, that the value must be fixed according to the actual condition of the works, resulting from wear and tear, or by reason of system or appliances having become in whole or in part obsolete, and having regard to the value of the works to the corporation purchasing, and the extent to which they can make use of same, and the cost of procuring more valuable and more modern improvements or appliances therefor. If provisions of that kind were made in regard to expropriation of private property, at the instance of a railway company, it would give rise to small-sized rebellion.

There is much more that could be said upon the subject, but it is likely that, except for the purposes of the City of Toronto and the desire of its aldermen who are anxious to acquire the gas company's property, the act is becoming, and will, in consequence of the provisions already made and in contemplation in connection with the distribution of Niagara power over Western Ontario, become of less and less practical importance. In many instances operation of the act has been unfortunate to the owners of plants, for instance at Kenora, and again down in the County of Carlton, and again at Midland, the owner got in each case somewhere in the neighborhood of 30 per cent. of the original cost of the plant, and it is not possible to see how, in view of the provisions of the act, he could hope to obtain full original cost therefor.

SPARKS.

Mr. Ormond Higman, Jr., B. Sc., consulting electrical engineer of Edmonton, has been granted a fifteen year exclusive franchise for electric lighting in the town of Fort Saskatchewan, Alberta.

Mr. Wilfrid Phillips, manager of the Winnipeg Electric Railway, states that it is the intention to electrify the road to Selkirk as quickly as possbile, but it will probably be six months before the work is completed.

The Western General Electric Company, Red Deer, Alta., are enlarging their electric plant, and have placed an order with the Robb Engineering Company for a 250 horse power compound Corliss engine and Robb-Mumford boiler.

The electric light plant at Trail, B.C., owned by the Consolidated Mining & Development Company, was destroyed by fire June 13th. The loss is $18,000, fully covered by insurance. The plant furnished the lights for Trail and for the Trail smelter.

The Cranbrook Electric Light Company, of Cranbrook, B. C., are investigating the advisability of installing its own water power system on Cranbrook Creek, about eight miles from the city. They have abundance of water and a 25 foot fall. At present the plant is operated by steam power, the steam being supplied to the Company's own engine by the East Kootenay Lumber Company, of Cranbroook.

Surveys are being made for the extension of the transmission line from Greenwood, B. C., to the Mother Lode mines of the British Columbia Copper Company and to the Boundary Falls smelter of the Dominion Copper Company, each being a distance of about four miles from Greenwood. Both of these concerns will substitue electricity for steam power on the completion of the lines. The work is being done by the British Columbia Contracting & Distributing Company, a subsidiary company of the West Kootenay Power & Light Company. The sub-stations are now being built at Greenwood and Grand Forks.

The power development for the Montreal Light, Heat & Power Company at Soulanges is under way. Water will be taken from the Soulanges Canal about 2,000 feet east of Lock No. 4, and will drop 55 feet to the water wheels and then through the tail race into the St. Lawrence river. The contract includes the construction of a canal about one-half mile long and 160 feet wide from the bottom with banks sloping 2 : 1. The construction of this canal will be similar to the construction of the Soulanges Canal. It is estimated there will be about 300,000 cubic yards of excavation required. The power house, penstock and dam will be constructed of reinforced concrete. The total development will be about 20,000 h.p., consisting of four units of 5,000 h.p. each.

The St. Francis Hydraulic Company, of D'Israeli, Que., have found that the demand for electric power is exceeding their present equipment, and have just placed an order with Allis-Chalmers-Bullock, Limited, of Montreal, for another 750 k.w. 3 phase, 60 cycle, alternating current generator, with step-up and step-down transformers, switchboards and other accessories. The necessary waterwheels will be supplied by the Jenckes Machine Company, of Sherbrooke. It is understood that the Asbestos & Asbestic Company, of Danville, have decided to make an extensive use of electricity in the operation of their mines and that other asbestos mines have the subject under consideration.

CONVENTION NOTES

The exhibits of electrical apparatus at the Canadian Electrical Association Convention were doubtless less numerous than if the Association had met on the Canadian side. There were, however, several interesting exhibits.

The Canadian General Electric Company occupied Parlors A, B and C on the second floor of the Cataract House, where they received their friends and proclaimed the merits of "C. G. E." apparatus. This Company distributed to the members a neat memorandum book, enclosed in leather cover.

The Oneida Community, Limited, of Niagara Falls, Ont., exhibited their popular galvanized chain for the suspension of arc lamps, a working installation being shown in the Cataract House.

The Canadian Westinghouse Company's exhibit was placed in the large first-floor parlor of the Cataract House, where the chief feature was the Nernst lamp for which the Canadian Westinghouse Company, Limited, are licensee manufacturers for Canada. The lamp was shown in all sizes and types. The new series lamp attracted a great deal of attention. This was shown in two types, for socket and goose neck suspension. Among the other detail apparatus manufactured in Canada by the Company was shown fan motors, recording wattmeters, transformers, and arc lamps.

Allis-Chalmers-Bullock, Limited, of Montreal, exhibited a number of beautiful framed bromide enlargements of some of the machinery which they have already built and installed during their short career. The most noticeable was the power house of the Northern Aluminum Company at Shawinigan Falls, Que., containing the largest inter-polar generators ever built. As usual, the company printed and circulated, at four intervals, the "Register" of names of those in attendance, which is always a serviceable feature of these conventions. The publication of this Register was under the direction of their advertising manager, Mr. John S. MacLean.

Exhibit of Pittsburgh Transformer Company at Canadian Electrical Association Convention.

The exhibit of the Pittsburgh Transformer Company was in charge of Mr. H. G. Steele, who worked energetically explaining the construction and merits of the apparatus exhibited. The company chose for its exhibit a complete line of 25 cycle transformers, these being of particular interest on account of the fact that the 25 cycle transmission is common at the Falls. In passing it may be mentioned that all of the transformers except one were disposed of by sale to one of the local power companies at the close of the convention. The company dispensed "Pittsburgh Smoke" in the shape of a popular brand of Pittsburgh stogie, there being boxes of these constantly on tap throughout the convention. The Pittsburgh Transformer Company is to be congratulated upon the handsome manner in which its product was exhibited at the convention.

No souvenir was more appreciated than that bearing the compliments of the Sunbeam Incandescent Lamp Company. It was a handsome purse of the best quality of leather, the inscription on which was designed to remind the recipient of the superior qualities of "Sunbeam" lamps.

Mr. W. A. Lewis, representing Messrs. J. A. Dawson & Company, dealers in street railway, electrical and mill supplies, Montreal, handed a silver paper knife to everyone present.

The Miller Anchor Company, of Hamilton, gave demonstrations of the working of the Miller safety anchor which has recently been placed on the Canadian market. This anchor is made of cast iron with rods of wrought iron, and is claimed to be easy to install and to have very great resistance.

The Winnipeg Electric Railway Company have announced a schedule of rates for power and lighting, consequent upon the completion of their electrical power plant on Winnipeg River at Lac du Bonnet. It is very satisfactory to the citizens, guaranteeing a reduction of from 50 to 70 per cent. in rates. Power is cut from twenty and twelve and one-half cents per hour for elevators and motors to six and four cents, respectively, and lighting will cost ten cents instead of twenty.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—I recently installed a large number of enclosed fuses in a factory in Port Hope, and since that time the new standard fuses of the Underwriters have come into use. I have been recommended to discard these old fuse blocks and substitute all New Code blocks, but as the expense of such a change would be material, I would be glad if you would advise me whether you think it necessary or not. Is there any chance of my not being able to get fuses to fit these old style blocks in the future?

Ans.—Your case is similar to many which have arisen recently where fuse blocks were installed just prior to the coming into force of the new rules of the Underwriters. The old fuses are perfectly safe to use, and offer just as good a protection as the New Code fuses. As you are doubtless aware, the old Code fuse of one manufacturer would not fit the block of another, and the only material modification as called for by the New Code, is that all manufacturers shall make interchangeable blocks and fuses. We would suggest that any new blocks which you install should be of the New Code typs, but there is no necessity for throwing out the old blocks. These old blocks are entirely acceptable to the Underwriters, and we do not think you will have any difficulty in obtaining fuses for them.

Ques. No. 2.—It is proposed to procure power for some plants by means of the wind which could be used to fill in some air reservoirs to a certain pressure which would supply the power when there is no wind. When the wind blows the reservoirs are filled but not used to supply the power. (a) Do you know of any such installation for small or large plant, industry or waterworks, etc.? (b) Give me the names of places and parties using such installations. (c) Give me names of concerns manufacturing such plants, whom I could write to and get information from.

Ans.—We regret that we have absolutely no information concerning the class of equipment about which our correspondent asks, but would suggest that he communicate with the manufacturers of windmills, both in Canada and United States. The only name which we have at present before us is that of the Ontario Wind Engine & Pump Company, Limited, Atlantic Ave., Toronto. We are inclined to think that the windmill people will be able to give you the desired information if any plant such as you mention has been installed. While a large amount of power could be taken from the wind, still the uncertainty of such a source has in the past made it a scheme of extremely doubtful value, and in this respect it may be ranked on a par with the appliances used for obtaining energy from the motion of waves. In order to get power from the wind in any reasonable quantity, the expense of installing the windmills and putting in storage reservoirs to contain anywhere near a reasonable amount would be very high, and we think it is quite likely that a small gasoline engine would be much more satisfactory and cheaper in the long run.

Ques. No. 3.—Where alternators are direct connected to engines and are to be run in parallel, would you recommend the cross compound engine in preference to the tandem compound? For a given horsepower what will be the difference in price between the two types of machine?

Ans.—Throughout various parts of Canada in direct connected parallel running alternating plants, cross compound engines as small as 250 horse power have been installed, and while we think this size is a little on the small sidz, still the results obtained from a cross compound engine are always worthy of consideration no matter what the size of equipment may be. In engines for this service, where the sizes run 400 horse power and upwards, we think we are safe in saying that the use of the cross compound engine is always desirable. This type has many advantages which cannot be obtained in a tandem engine, smaller variation in angular velocity being one of the chief features, as the machine has four impulses per revolution as against two in the tandem. In the smaller types of machines the difference in price for a given horse power may have a material effect when considering the purchase of such equipment, but in the larger sizes the cross compound machine will cost but little more than the tandem.

Ques. No. 4.—Is the figure of $16.53 per horse power per year given in the Hydro-Electric Report as the price for Toronto, anywhere near the cost at which such power will be sold?

Ans.—$16.53 represents the cost of the power delivered at the Toronto substation and including that structure, on a basis of a 50,000 horse power load. To get the price at which power should be sold in Toronto you will have to add to the above figure the cost of distributing the energy to the secondary substations, and the cost of distributing the power from the secondary substations to the consumer. On top of this you would have to add the percentage of profit which the company will demand, and then you will have a figure which will no doubt very closely approximate the price at which power will be sold, on the basis of a load of 50,000 horse power. This load, however, does not exist at the present time, and it will probably be many years before such an amount will be required by the City of Toronto. Therefore, to get the present cost, the basic price of $16.53 will have to be increased according to the amount of energy demanded in the immediate future, and the additions made thereto as mentioned above.

Ques. No. 5.—If you will give me the following information through your columns, in connection with storage batteries, I shall be obliged. (a) What is the voltage across the terminals of each cell at the end of the charge while the charging current is still on, and what will this drop to when the charging current is stopped? (b) What voltage per cell is considered the danger point at the end of the discharge? (c) What is the regulation of a cell from no load to full load? (d) What is the efficiency of a good storage battery?

Ans.—(a) When the charge is complete, that is to say, the occasional overcharge, the voltage per cell will run as high as 2.6, and will drop to 2.1 to 2.15 when the charging current is stopped. Probably the voltage at the end of an ordinary charge will not exceed 2.4. (b) When a cell gets down to between 1.75 and 1.8 volts, the discharge has been carried as far as good practice will allow. (c) The only figures covering regulation which we have show the volts of a fully charged cell when delivering current at the eight hour rate of discharge and at the one hour rate of discharge, the floating voltage being given as 2.08. With the cell temperature at 80 degrees Fahrenheit, the voltage at the terminals at the eight hour rate of discharge will be 2.05 and at the one hour rate of discharge 1.97. (d) The ratio of the energy which can be taken out of a storage battery to the amount which is put in will be approximately 85 per cent. for first-class apparatus. For further details of the above, we would refer you to any maker of storage batteries.

THE DOMINION WIRE MANUFACTURING COMPANY.

One of the most enterprising concerns in Canada is the Dominion Wire Manufacturing Company, of Montreal, of which Mr. F. W. Fairman is president and Mr. A. E. Hanna secretary-treasurer. This company manufacture copper and galvanized wire and wire goods generally in very large quantities and have

Mr. F. W. Fairman,
President Dominion Wire Manufacturing Company.

constantly on hand a number of important contracts. Their business is growing rapidly, and almost every year it has become necessary to enlarge their factory. They make a specialty of wire for telegraph, telephone and transmission lines. Their advertisement will be found on page i.

THE ELECTRICAL TRADES EXHIBITION IN MONTREAL.

An impression seems to prevail in some quarters that the Electrical Contractors Association of Montreal are not supporting the Electrical Trades Exhibition which

Mr. A. E. Hanna,
Secretary-Treasurer Dominion Wire Manufacturing Company.

is to be held in that city in September. We are informed that such is not the case. A few manufacturers pleaded that there was insufficient time allowed them to exhibit, but quite a number of exhibitors have already signed contracts for space, in fact to such an extent that there is but little space left.

The Contractors' Association have promised to assist Mr. E. W. Sayer, the president of the Association, in any way they can, and they will be in evidence at the Victoria Rink to assist the public in understanding the various exhibits.

It is yet too soon to name the various entries, but there are many novelties promised which will particularly interest the public, the supply man, and the contractor generally.

MARITIME ELECTRICAL ASSOCIATION CONVENTION.

The following is the program of the summer convention of the Maritime Electrical Association to be held at Sydney, C.B., July 18th, 19th and 20th :

Wednesday, July 18th.

Morning Session.—9.00 a.m.: Meeting of Executive Committee. 9.30 a.m.—Address of welcome from the Mayor of Sydney; Reply by President; Business meeting.

Afternoon.—1.30 p.m.: The members will leave the C. B. Electric Company's wharf for an excursion on the Harbor, landing at the International Pier at 3.30 and walk through the Dominion Iron & Steel Company's works, taking special cars at the upper end.

Thursday, July 19th.

Morning Session.—9.00 a.m.: Paper by Prof. Dahl: "Wind Power Applied to Electricity." Paper by Mr. A. F. Townshend: "Auxiliary business to be obtained

Mr. John T. Farmer,
Mechanical and Hydraulic Engineer, Montreal.

by electric companies through electric heating, fans, irons, charging automobiles with mercury arc rectifier, etc." Discussion on best methods of obtaining new business.

Afternoon.—1.30 p.m.: Trip to North Sydney and Sydney Mines to inspect the works of the Nova Scotia Steel & Coal Company.

Friday, July 20th.

Morning Session.—9.00 a.m.: Reports of Committee on "Pole Rentals." Discussion on methods of dealing with customers' complaints. Paper by Mr. J. H. Winfield: "The Evolution of the Telephone." Question Box.

Afternoon.—1.30 p.m.: Trip by electric cars to Glace Bay and the collieries of the Dominion Coal Company.

Evening.—Banquet at the Sydney Hotel.

The Robb Engineering Company, Amherst, N. S., are building for the Hamilton Iron & Steel Company a 250 horse power engine for direct connection to Westinghouse generator.

The Savonas Land & Lumber Company has been incorporated in British Columbia as an extra-provincial company, with a capital of $240,000. It is understood that the company intend utilizing the water power now going to waste between the outlet of Kamloops Lake at Savona and the Horseshoe Bend for the generation of electricity. Power will be transmitted to Kamloops and intermediate customers who may desire power or light.

MONCTON'S LIGHTING PLANT.

The lighting and power plant of the City of Moncton, which has been in operation for over twenty years, is now under municipal control. When first introduced the plant consisted of one 40 light T.H. open arc machine driven by a common slide valve engine which was supplied by steam from the Sugar Refinery boilers. The plant has been increased from time to time as the demands required and at present a considerable enlargement to the plant is being made, of which the following is a description:—

The building is a brick structure with boiler room 42 x 41 feet; engine and generator room 58 x 50 feet; pump and heater room 29 x 21 feet; brick chimney 100 feet high.

The walls of the building have been raised and new trussed roof constructed, doing away with all supports, thereby giving a clear floor space. The installation of a new boiler has been competed, also new steam main and the steam piping all remodelled.

Work is now in progress installing a new engine and generator direct connected, having a capacity of 300 k.w. The engine was made by the Robb Engineering Company and the generator by the Canadian General Electric Company.

A day load is in operation and small motors to the amount of 75 horse power are installed. The meter system both for power and light prevails.

When completed the extent of the plant will be double the capacity, as follows :—

Four return tubular boilers, 16 feet x 60 inches and 16 feet x 72 inches, one Leonard Ball compound engine 17 x 26 x 16 driving a 150 k.w. two phase S.K.C. generator and 60 k.w. generator of C.G.E. make, Robb-Armstrong engine, 26 by 24 in., direct connected to 300 k.w. generator, two phase. These units run alternately to suit conditions of load. There is also part of old plant, consisting of 12 x 12 in. Leonard Ball engine driving 60 k.w. generator for day load, also 9½ x 12 in. Armington & Sims engine driving a 35 open arc machine for street lights.

Part of the street lights are of the enclosed arc type and when the new plant is installed it is the intention to change them all to this system.

The building is so constructed that an additional and generator can be easily installed.

J. Edington,
City Engineer.

Index—(Continued)

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XVI. AUGUST, 1906 No. 8

New Power Plant of the Saraguay Electric Light and Power Company

The new power plant of the Saraguay Electric Light & Power Company was officially opened on the 22nd of June, by the Hon. Lomer Gouin, Premier of the Province of Quebec. The power house is situated half way between the village of Cartierville and the town of Bordeaux, on the banks of the Laprairie river, otherwise known as the Back river. The works supply electric light and power to the various municipalities in the district, and there is an up-to-date pumping station for the water-works supply to the town of St. Laurent.

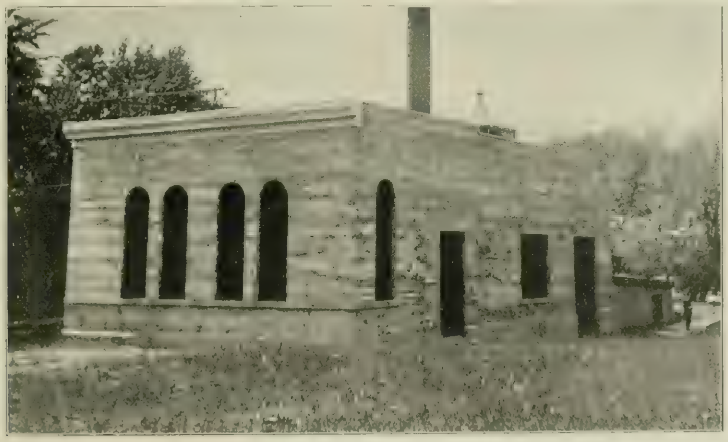
The construction of the plant was commenced in September, 1905, and on March 7th of this year, while not quite completed, it was supplying electric light to the towns of Bordeaux and St. Laurent. It supplies at present 100 street lights of 16 and 32 c.p. capacity.

The building, 98 feet long and 38 feet wide, is of solid concrete fire-proof construction. It is a steam plant, consisting of two Babcock & Wilcox boilers, one Peerless steam engine manufactured by E. Leonard & Sons, of London, Ont., and one direct connected three-phase 2200-volt generator and one exciter, manufactured by the Canadian Westinghouse Company, giving a capacity for supplying approximately 3,000 lights connected on the line. The capacity of the plant, however, is shortly to be increased to 500 h.p. The iron chimney is 4 feet in diameter and 90 feet high.

The steam engine is at present non-condensing, but with the installation of the new engine it is proposed to make it a condensing steam plant.

The four panel blue Vermont marble switchboard and the meters were also manufactured by the Canadian Westinghouse Company, while the transformers are of the Westinghouse and C. G. E. types.

The plant is provided with all the usual up-to-date coal and labor saving devices, including superheaters installed in the Babcock & Wilcox boilers, which superheat 100-120 Fahrenheit. There is a Webster vacuum feed water heater supplied by Messrs. Darling Bros., of Montreal, the feed water being heated by the exhaust steam of the engine to a temperature of 209-210 Fahrenheit.



SARAGUAY ELECTRIC LIGHT & POWER COMPANY—SIDE VIEW OF POWER HOUSE.

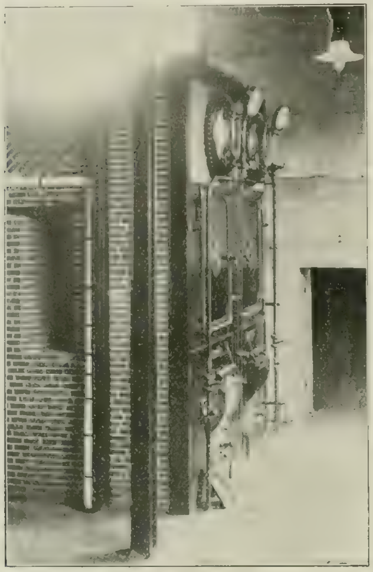
The plant was built by Mr. E. Champagne, of Montreal, who is still the principal owner. Mr. Charles Brandeis, consulting engineer, of Montreal, prepared the plans and is chief engineer for the company. Messrs. Finley & Spence, of Montreal, were the architects.

The company has recently secured contracts from the villages of Ahuntsic and Cartierville. Ten miles of line have been completed and several miles are under construction.

The Saraguay Electric Light & Power Company have installed a triple expansion condensing double

direct acting Worthington steam pump of 15,000 gallons per hour capacity, and as before mentioned supply the water-works for the town of St. Laurent, an additional pump of 9,000 gallons per hour capacity being installed for emergency purposes.

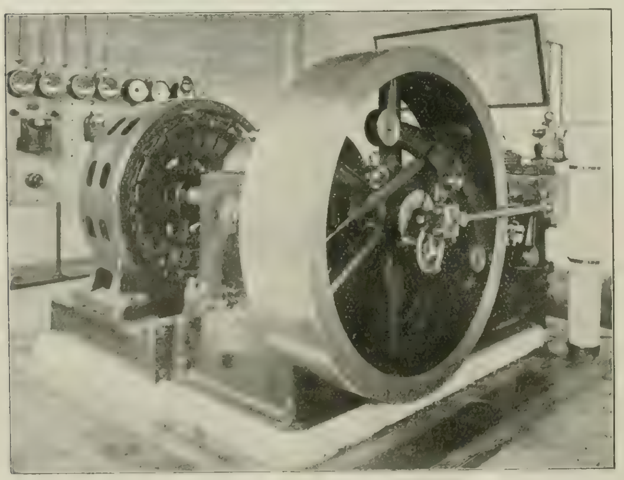
The officers of the company are: President, E. Champagne; vice-president and consulting engineer, Charles Brandeis; secretary-treasurer, W.R. Cunningham. The provisional directors are: A. Champagne, Theodore Fuisy, Hector Champagne and Charles Brandeis.



SARAGUAY ELECTRIC LIGHT & POWER COMPANY—BABCOCK & WILCOX BOILERS, WITH SUPERHEATERS

THE OFFICIAL OPENING.

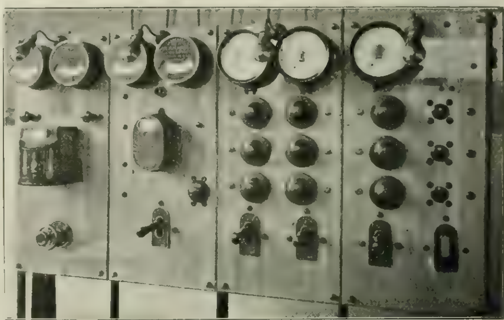
The invited guests and directors of the company left Montreal by special car at 3 p. m. Friday, June 22nd. Upon arrival at the works it was seen that a large number of flags were hung around the building, and that careful preparations had been made to entertain the guests.



SARAGUAY ELECTRIC LIGHT & BOWER COMPANY GENERATING UNIT.

After inspecting the works the guests assembled near the power house and listened attentively to speeches by Premier Gouin; J.L. Decarie, M.P.P. for Hochelaga; Duncan McDonald, general manager of the Montreal Street Railway Company; Hon. Judge Champagne; E. Lusier, Mayor of Bordeaux, and Achille Bergevin, M. P. for Beauharnois. Each speaker complimented the company on the progress that had been made and the general appearance of the works.

Others not already mentioned who were guests of the company were Jas. Quinn, Alex. Michaud, A. Gaboury, Jas. Bennett, F. Labelle, F. Lester, S. W. Smith of Canadian Westinghouse Company, Geo. H. Muir, C. Lester of John McDougall Caledonian Iron Works, C. A. Pariseault, Dr. C. Ethier, V. Guertin, Jos. A. Lamarche, H. Morin, P. Decarie, sr., Louis Masson, Dr. Alphonse Mercier, Dr. A. Ethier, Jean Versailles and J. L. Lafleur, also J.A. Christin, Mayor of Ahuntsic; P. Cousineau, Mayor of St. Laurent; A. Plouffe, Mayor of Cartierville, and A. Poitras, Mayor of Sault au Recollet.



SARAGUAY ELECTRIC LIGHT & POWER COMPANY—SWITCHBOARD IN POWER HOUSE.

THE DARKNESS EXPLAINED.

The following was innocently published in a recent issue of the Welland Telegraph in explanation of a temporary shut down of the electric light plant, due to a short-circuit in the armature as the result of copper dust:

"Something went wrong with the electric light service last night shortly after eight o'clock and for half an hour the darkness was turned on. The Telegraph called up the electric light station to enquire the nature of the accident and was informed that the allamagoozalum had blown out. A reporter was soon on the spot and found Mr. Page and Mr. Houston wading knee deep in the amperes of the electric fluid that had spilled out on the floor. The engineer lay stretched on the grass with several kilowatts of the allamagoozalum embedded in his neck. The allamag, etc., is a technical name which means load factor."

Cost of Electric Power

A correspondent signing himself "Veritas" has written a somewhat lengthy letter to the Toronto News in reference to the report of the Ontario Power Commission, in which he shows very clearly that the usual basis for municipal ownership charges for electric light is wrong, inasmuch as it entirely ignores the "load-factor." On this subject, and dealing especially with the Hydro-Electric Commission's report on Niagara power, he says :

The communications which have appeared in the press from time to time from various correspondents miss the most salient point of the whole question. You can hardly be blamed, therefore, for ignoring the same point, as it is in a sense mainly a technical one with which you are not expected to be familiar. Mr. J. Stanley Richmond, in his communication to the daily press under date of April the 16th last, made an attempt to deal with this point in the ninth paragraph of his letter, but unfortunately he referred to it in the term "power-factor," instead of "load factor," the latter being the correct name. Furthermore, he did not give the discussion the prominence it deserves. Any person upon making enquiries for himself will discover that in any city approximating the size of Toronto, it is quite possible to have, as the Hydro-Electric Power Commission report shows, a total capacity of motors connected to the lines having an aggregate capacity of 50,000 h.p. or more. But the same person, upon pursuing his enquiries further, will find out for himself that though there may be 50,000 h.p. in electric motors in the city, connected to the lines and ready for work, at probably no instant at any time of the year will the whole 50,000 h.p. be in use. The experience of large central stations supplying power to consumers, after years of operation, is that on the average the amount of power in use, or, in other words, the load upon the central station, rarely exceeds for more than a few hours of the day 50 per cent. of the total connected load throughout the city, and as a matter of fact, the proportion is usually from 30 per cent. to 40 per cent. In other words, assuming a connected load of 50,000 h.p., the average load thrown upon the central station throughout the day will be from 15,000 to 20,000 h.p., although it will necessarily happen that the load may run up to 25,000 or even 30,000 h.p. for a couple of hours, and may at rare intervals reach 40,000 h.p., but a very careful search of the records available for twenty years shows that at no time has the full load of 50,000 h.p. ever been thrown upon the station. The 40,000 h.p. load is most likely to occur between the hours of 4 p.m. and 6 p.m., from October 1st to April 1st, that is to say, during the winter season, when the incandescent lighting loads and motor loads coincide. To apply the argument to the individual consumer, let us suppose that he has installed in his factory 1,000 h.p. of electric motors and 1,000 incandescent lamps. Let us assume that he has an ordinary manufacturing establishment, such as a machine shop, furniture factory, or any other mauufacturing establishment, in which the 1,000 h.p. of motors are distributed among a number of different machines. It makes little difference whether one motor of 1,000 h.p. be used, or 100 motors of 10 h.p., or any other combination, the experience of such a factory is that the average load is from 30 to 40 per cent., or 300 to 400 h. p. of the 1,000 h.p. installed, notwithstanding the fact that the momentary load may be for short intervals 800 or 900 or even 1,000 h.p. During the winter season he wil draw from the central station for an hour and a half, 4.30 to 6 p.m., 100 h.p. for his incandescent lamps, thereby making his maximum possible load 1,100 h.p., and raising his average from 300 to 400 h.p. to about 500 to 600 h.p. His average load factor is, therefore, 30 per cent. to 40 per cent. during the summer, and about 40 per cent. to 50 per cent. during the winter.

EXHIBIT OF THE CANADIAN WESTINGHOUSE COMPANY AT THE CANADIAN ELECTRICAL ASSOCIATION CONVENTION.

LOAD FACTOR ILLUSTRATED.

To apply the argument directly to the tax-payer, who uses nothing but incandescent light in his house and no motors, let us assume that he has 30 incandescent lamps installed and that being an economical person, he will use only such light as he requires, which will average from three to ten lamps. The load factor of that particular customer is 10 per cent. and 33 1-3 per cent. respectively. Now let us assume that the householder is paying $1 per lamp per annum on a flat rate, that is to say, he pays $1 per lamp whether

he uses the light or not. His total bill is, therefore, $30 per annum, a fixed amount. But if he uses on an average only 10 lamps out of his 30, he is actually paying $3 per lamp per annum instead of $1 per lamp, and likewise if he uses only three lamps on an average he is paying $10 per lamp per annum. This customer would naturally feel disposed to have a meter put on his lines if he can effect a saving on the $30 flat rate by being economical in the use of his lamps, which past experience shows can be done.

Again, let us assume that the manufacturer is offered a flat rate of $20 per h.p. per annum. His fixed annual bill will be $20,000 for his 1,000 h.p. of motors installed in his factory, but if his average load is, say, only 400 h.p. per annum, he is actually paying for the power he uses at the rate of $50 per h.p. per annum, for the reason that his bill is $20,000 for the 400 h.p. used. Naturally this customer can and will reduce his annual bill by taking advantage of a meter rate rather than a flat rate, because he cannot change his load factor materially.

Now, to bring this argument up to the point where it concerns the citizens of Toronto generally, let us take Table 35 of the Hydro-Electric Power Commission report, which shows the annual charges for generating, transmitting, transforming, and distributing 36,272 h.p. in Toronto to be $956,474. According to Table 36 of the same report, however, we must pay for only enough power to equal the maximum demand, therefore we must pay for 33,772 h.p., which, if bought at cost of generating, transmitting and transforming only, will be at the rate of $17 per h.p. per annum, as stated in the report, but, as is not stated in the report, only provided every single h.p. of the 33,772 h.p. be purchased and paid for whether sold or not. According to Table No. XXXV, the cost of distributing the power from the local sub-station low tension side is as follows:

Operating and administration expenses, and fixed charges of the local distribution system....	$365,107
Taxes, as now paid by the Toronto Electric Light Co..................................	18,243
Annual total cost of distributing..............	$383,3 0
Add cost of 33,722 h.p. transmitted at $17	574,124
Annual cost of power delivered to consumers...	$957,474

$957,474 divided by 36,272 h.p., sold according to Table XXXVI, means a net cost of $26.40 per h.p. per annum, only on the assumption that every horse-power of the 36,272 h.p. be sold and be paid for by the consumer whether they use that amount of power or not.

PAY WHETHER USED OR NOT.

But, right here the question of load factor comes in, and it has a most vital bearing upon the cost of power to the consumer. Bear in mind that the city of Toronto, in order to get its power for $26.40 per h.p. per annum must contract to pay for $33,772 h. p. each year, whether the city uses that amount of power or not, either for its own purposes or through the motors and lamps in the establishments of the citizens. According to the well-known experience of central stations in other cities approximating the size of Toronto, whether these stations be operated under municipal or private control, makes no difference, the average load continuously on the station is from 30 per cent. to 40 per cent. of the total load connected to the lines. But to be liberal, let us suppose that this average load is half the total connected load, or, in other words, that the load factor of the station or plant is 50 per cent. The citizens will, therefore, be using continuously each year, not 36,272 h.p., but 18,136 h.p., for which the city shall have contracted to pay the sum of $956,474 per annum, which, divided by the average power used, namely, 18,136 h.p., means a cost to the consumer of $52.80 per h.p. per annum, or exactly double the rate they have been led by the report to anticipate. Now, while this statement may appear to be somewhat complicated, a little careful attention on the part of the reader will enable him to see that, if the load factor has been correctly assumed, the results quoted are correct. As I have said before, the question of load factor can be investigated in any large central station, and particularly right here in Toronto.

A MASTERLY REPORT.

That the report issued by the Hydro-Electric Power Commission on the subject of Niagara power is a masterpiece, any fair-minded person will have to admit. The engineers of the commission deserve much credit for their thoroughness, and, taking into consideration the mass of data, the accuracy of their figures and results in a general way, the report is valuable not only for the interesting and useful statistics which it publishes, but as presenting a plan for a basis of intelligent comprehension on the part of the public. But in my mind the report should have dealt prominently and unequivocally with the question of the load factor and its effect upon the cost of power to the consumer, as the report, in its present form, is apt to be misleading, though, in fairness to the commission, let us assume that it was not intentionally so.

Before closing let me point out an apparent discrepancy, which may be a real one, in regard to the estimated cost of power delivered at Toronto. In Table XVII, the report estimates the cost of transmitting, transforming and delivering power at the low tension side of the sub-station to be $16.53 per h.p. per annum, which is later assumed at the round figure of $17 per h. p. in Table No. XXXV, referred to above. But this rate is based upon a total load of 50,250 h.p. To be consistent the report should have divided the total transmission and transformation expenses of $173,519 per annum (Table No. XXIII) not by 50,250 h.p., which equals $3.45 per annum per h.p., but by 33,772 h.p., which equals $5.14 per annum, hence the cost of power at the high tension side of the power house assumed by the report to be $13.08 on the basis of a flat rate of $12 per h.p. paid at the Falls, is increased by $5.14, making the cost of power at Toronto sub-station ready for distribution $18.22 instead of $17, as assumed in Table XXXV. Without occupying further space with calculations I will conclude by stating that the final cost of power to the consumer on this basis will be $27.52 per h. p. per annum if the entire quantity of 36,272 h. p. be sold outright, or if the load factor be 50 per cent., as in other cities, the cost will be $55.04 per h.p. to the consumer.

Collyer & Brock, electricians, Montreal, have been succeeded by Guy N. Brock.

The Georgian Bay Power Company are asking for tenders for the construction of a dam and abutments at Eugenia Falls, Ont., in connection with the power development there. The length of the dam will be 80 feet and the height 40 feet.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUESTION No. 1.—Will you kindly advise me through your columns the relative advantages of enclosed fuses and circuit breakers. Which is the better to use and what are the conditions which call for the installation of either? What is the use of the "time limit relay"?

ANSWER.—The enclosed fuse is primarily intended for the protection of low current circuits, though the progress made in the manufacture of such articles has enabled the makers to place enclosed fuses of considerable size on the market. The enclosed fuse is cheap to install and cheap to replace, and in small sizes can really be depended upon better than a circuit breaker. In any event, for the protection of low current circuits, the cost of a circuit breaker makes the use of such an article prohibitive. There is always one thing in favor of a fuse, namely, its action is not instantaneous, and therefore a very desirable time element is incorporated. Fuses of large capacity are expensive to install and exceedingly expensive to replace, and we would be inclined to think that for accuracy they would not compare favorably with circuit breakers. The circuit breaker has a great deal in its favor for large current circuits, and even for high potentials the break is very quick and very clean, and in combination with magnetic blowout devices its action is very sure. Possibly the quickness of a circuit breaker may, from certain standpoints, be regarded as a disadvantage, and this fact has led to the introduction of the time limit relay, which brings an adjustable time element into the action, making said action very similar to that of an enclosed fuse. A circuit breaker with a time limit relay may be adjusted to open at a predetermined current, but without the relay the action would be instantaneous. With the relay the opening can be made to take place from half a second to perhaps five seconds after the current has reached the predetermined point. Thus, in large power stations, with long distance transmissions, the circuit breakers are almost invariably equipped with time limit relays. If a short circuit should occur at the distributing end, sufficient to open the breakers, the entire station would be shut down, but with the time limiting devices the power house breakers cannot open for say three seconds after the overload occurs. In all probability the outgoing line from the substation, upon which the short circuit occurs, will be equipped with a time relay set for one second, and hence, when the before mentioned short circuit occurs, this circuit breaker will open, the power house breakers will not open, and the system will be left running with the exception of one disconnected circuit. You can readily appreciate the advantages obtained from such an arrangement.

QUESTION No. 2.—Can you give me instructions for making an efficiency test on a direct current motor by means of a brake?

ANSWER.—In connection with the above test, a number of pieces of apparatus are necessary. These we will take up in order. An ammeter and voltmeter will be required for measuring the input of the motor under various loads, and a tachometer or speed indicator will be required for taking the speed of the motor. The prony brake consists of friction blocks which clamp around the pulley of the motor, the tension of said blocks being adjustable. From these blocks an arm runs out and rests upon the platform of a scale. Unless the brake proper is arranged to balance, considerable care will have to be exercised in getting the net weight of the brake arm, and this can best be done by loosening the blocks and inserting a round lead pencil under the upper block, thus allowing the brake to press unhindered upon the platform scale. The weight of the brake arm may thus be measured, and said weight must be deducted from the readings during the test. It is customary to have a special type of pulley on the motor for making such tests, as the energy of the motor is dissipated to the atmosphere in the form of heat, and friction blocks will, as a result, get exceedingly hot. It is usual to equip the pulley with inward projecting edges, so that cooling water may be poured in, to reduce the high temperature mentioned. Devices are often used to continuously replace this water, which action will be necessary if your test is of any duration. The length of the brake arm being known and the torque exerted by the motor being measured by the scale, a combination of these two, with the speed of the motor, will give you the foot pounds exerted per minute. This reading is reduced to horsepower, and the electrical input of the motor is reduced to the same basis. When the output is divided by the input the result will be the efficiency of the motor in per cent.

QUESTION No. 3.—Is there a wattmeter made which will show either the volts or the amperes as well as the watts?

ANSWER.—We understand that a meter has recently been placed upon the market which reads watts, amperes and volts simultaneously, though we have not yet had an opportunity of testing the instrument in actual service. The arrangement is very ingenious and should make the instrument a very valuable one. We presume that the device is manufactured for the testing of incandescent lamps, and in this connection its field should be large. The instrument is really an ammeter and a voltmeter combined in one case, the needles being entirely independent. Each needle has its own scale and therefore the amperes can be read independently on the ammeter scale, and the volts on the voltmeter scale. The needles are arranged so as to cross and the watts are read at the point of intersection of the needles on a special scale located immediately under such point. This arrangement will make the meter accurate for any voltage, which is a disadvantage which some of our present wattmeters have, same being accurate only within a certain percentage of a standard voltage.

QUESTION No. 4.—What is meant by the term "hydraulic mean depth"?

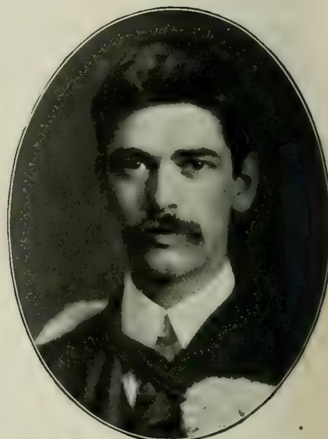
ANSWER.—The hydraulic mean depth or the "mean radius" as it is sometimes called, is found in the following manner: The cross sectional area and the wetted perimeter of a stream are ascertained, the latter being the width of the bed of the stream in contact with the water. When the area is divided by the wetted perimeter, the quotient is the hydraulic mean depth.

C. V. Christie, Halifax, N. S.

F. H. Barrington, Waterloo, Que.

A. D. Gurd, Montreal.

G. E. Brennan, Ottawa.



A. M. Gray, Edinburgh, Scotland.

M. L. Hibbard, Farnham, Que.

R. K. Durland, Yarmouth, N S.

J. Harvie, Westmount, Que.

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J. DeL. Purdy, Springhill, N. S.

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H. P. Thomas, Victoria, Australia.

Ian McLeish, London, Eng.

R. Mudge, Montreal.

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CANADIAN

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of his journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Atmospheric Electricity.

One of the most recent schemes for attracting gullible investors is outlined in a prospectus issued by a certain American company, which has for its object the utilization of the "enormons amount of free electricity in the atmosphere". That electricity exists in the atmosphere we are of course quite ready to admit, though as to the quantity and to the possibility of utilizing it there is considerable doubt. We are used to considering the potential of a lightning discharge as something enormous, such reasoning being based upon the length of the discharge compared with voltages requried in our own experiments to make a discharge jump a given distance. In regard to lightning this theory may be incorrect, as Dr. Steinmetz recently expressed the opinion that the voltage of such discharges is very much lower than usually considered. No data exists on the possibility of obtaining electricity from the atmosphere, most experimentists in this line having encountered the inconvenience of being killed at their work. Our American company, however, goes on the basis that inasmuch as the existence of atmospheric electricity is admitted, and that there is no positive proof as yet that it cannot be utilized, therefore the possibility of such use logically exists, and for their investors they paint a future in brilliant colors. However, as before pointed out, at the present time there is no hope of our being able to utilize the electricity in the atmosphere. First, we will have to find out how we can utilize it, and second, how great is the supply, and then possibly our enterprising friends may find their project on a commercial footing.

Smoke.

The smokeless chimney agitation which has been raised from time to time in various cities in the United States and Canada, brings forward a very interesting phase of the personal equation. With one fireman a certain manufacturer will have success so far as economical operation of his boiler plant is concerned and will receive very few complaints from civic authorities regarding violation of the smoke nuisance by-laws. In the hands of another fireman the same plant will give trouble, the smoke will be exceedingly bad, and much coal will be consumed. The whole secret of smokeless firing rests on the maintenance of a high furnace temperature, and when this is attained good economy will result and there will be little or no smoke. There are many devices on the market known as mechanical stokers, for which smokelessness is claimed, and when these devices are properly operated, they usually produce the desired result. Their chief weakness lies in the personal equation, for the devices can be abused, and frequently are. Practically all the furnaces are designed to run the coal through a series of steps, the first process being a coking and the second being an actual combustion. The lack of facility for forcing many of these devices and the inherent desire on the part of some firemen to continually stir things up is responsible for the lack of smokelessness. Where a fireman will operate a mechanical stoker strictly in accordance with directions, and such stoker is built upon rational lines, the owner will find himself in possession of a device satisfactory from every point of view, and such a man will be a strong advocate of this class of apparatus. On the

other hand, where proper attention is not given to a mechanical stoker, the owner will hold directly opposite views, and will condemn unjustifiably the entire tribe of such appliances as useless. Outside of the before mentioned points, the mechanical stoker, when installed in large boiler plants, will show a material saving in the labor item. With ordinary hand firing, it is the habit of the great majority of firemen to throw in immense quantities of coal at long intervals. The immediate effect of such action is to throw a blanket over the fire, which will at that time be at a low stage. It will be some minutes before the proper temperature is reached again, and during this period immense volumes of smoke are given forth. When the fire burns up to a bright white color, a maximum temperature is reached, with no evidence of smoke, and this condition continues to exist until the fire burns pretty well down and another dozen shovelfuls of green coal is thrown in on top of it. The fallacy of such a system of firing is apparent, and satisfactory results cannot possibly be obtained under such conditions. If the fireman puts on small quantities of coal at very frequent intervals, keeps his doors closed as much as possible, and makes a proper regulation of his dampers, so as to keep a constant steam pressure, a great improvement in results will be experienced, and the life of the boiler will be increased, to say nothing of the betterment of the smoke difficulty.

The Engineer's Future

The electrical engineer of to-day who has confined his work entirely to theoretical fields, has, comparatively speaking, very little chance in competition with his brother worker who, in addition to much practical experience, has been trained in commercial ways. It was not very long ago that the salesman handling electrical apparatus was of the ordinary type, that is to say, his success depended entirely upon his ability as a salesman, and the engineering side of his education, admitting for the sake of argument that he knew the difference between a shunt motor and a rheostat, was one of the smaller considerations. Engineers at that time were not considered as possessing the requisite instincts of good salesmen, and such men did not have, and were not expected to have, commercial training. Then there came into the field the theoretically trained engineer, with practical experience in the actual handling of apparatus, and in whom the commercial instinct was strongly developed. In competition with such a man the mere expert salesman had no chance. Slowly but surely the change has been made, and we find that our salesmen of to-day are all trained practical engineers who are constantly called upon to use their engineering knowledge in connection with their work. We could mention several names to-day which have become famous simply because the owners, besides being capable engineers, are good business men. These men have interested themselves not only in the engineering of many projects, but have had the financial side under their care, with the direct result that matters entrusted to their attention have turned out successfully. The young man as he comes from college to-day with his diploma has two serious handicaps, both of which must be overcome before he can be successful even in a modest way. In the first place he thinks, to use an old explanation, that all it is necessary for him to do is to announce the fact that he is ready to take a position, and then put a placard outside his house reading to the effect that the line will please form to the right. This, clearly, is a mistake, and it is not long before the young engineer makes a radical change in his opinion of his own importance. When the immediately expected position at five thousand dollars a year dwindles down to a six months wait at the end of which he finds thirty a month, the effect is very beneficial, and our engineer "finds" himself. The other point is lack of practical experience, and this experience can be obtained only through years of hard and constant work. To our mind the ideal engineering education would consist of public and high school training which would be followed by about two years in college. Then our man should enter upon an apprenticeship course, such as can be obtained in the shops of several of our largest manufacturers, and should spend at least three years at this work. The remuneration is small and there are many stumbling blocks, but without strenuous work success cannot be obtained. On the completion of his shop course the engineer should go back to college and there finish his education, taking, as the case may be, either one or two years more according to the calendar of his college. If he has in him the inherent qualifications of a good engineer he will leave his college a first class man in every respect. His education may have taken seven or eight years to complete, and he will be pretty well along in years, comparatively speaking, when he is ready to start his life's work, but the time will not be wasted, for for such a man the five thousand dollar position is waiting, and the thirty dollar a month job need not enter into consideration. The young engineer should never for one moment overlook the importance of the commercial side of engineering, for without this side the technical part of the business would be non-existent. He may be inclined to consider that commercialism is below him, and if such be his attitude he would probably be better in some other line of work, unless of course he be aiming at a professorship in some college. One of our leading consulting engineers advised us not long ago that every year at the close of the midsummer college term, he receives anywhere from twenty to thirty applications for positions in his office, and upon advising such applicants to enter shop work or work with a commercial company, has almost invariably received replies to the effect that consulting work was desired. Where such a notion originates is difficult to say, but our colleges should make every effort to eliminate such high-toned ideas from the minds of their graduates. The statement so often made that the electrical profession is overcrowded, is absolutely untrue. There are thousands and thousands of thirty and fifty dollar a month men, and a lamentably small number of five and ten thousand dollar men. For each of the latter there are dozens of positions waiting, and there always will be, for the demand exceeds the supply, many, many times. Therefore we say that an engineering education, to be worth while at all, should be complete, and no young man entering college who has made resolutions to really complete his education, fully and thoroughly, need have any fear of his future in electrical engineering.

THE ELECTRICAL PLANT OF THE CANADIAN-NIAGARA POWER COMPANY

By H. W. BUCK

The plant of the Canadian Niagara Power Company was the first of the power houses on the Canadian side of the Falls to be designed and to have construction work begun upon it. As soon as the decision was made to go ahead with this development the question was raised as to whether the plant should be identical with those of its allied company, the Niagara Falls Power Company, on the American side, or whether engineering advances had taken place since their completion sufficient to justify changes and improvements. In general it was decided to adopt the same system of development, but certain essential changes were introduced :—

(1) Generating units of 10,000 h.p., instead of 5,000 h.p., were adopted.

(2) Generated voltage was raised to 12,000 volts.

(3) Generators were wound for 3-phase instead of 2-phase.

When the 10,000 h.p. generators were ordered for this development they constituted the record to date for capacity, and were for a short time the "largest in the world," but, like all records in electrical work, it was of short duration. At present there are a number of machines in operation somewhat larger than these in rating, and others are being seriously considered for certain installations which will be nearly twice as large.

It was decided to change from 5,000 h.p. to 10,000 h.p. for the generating units —

(1) To reduce the length of the wheel pit, power house, forebay, etc., and consequently to reduce their cost of construction.

(2) To reduce the cost per h.p. of the generators, water wheels, etc.

(3) The load of the Niagara Falls Power Company and its ally, the Canadian Niagara Power Company, had become so large that a unit of 10,000 h.p. could be installed without having such unit represent too large a proportion of the total load, from the standpoint of convenience and flexibility of operation.

The decision to have the generators wound for 12,000 volts was made to effect economies in station wiring and in the system of underground distribution necessary to transmit the power from the power house outside the limits of the Victoria Park. The particular voltage of 12,000 was selected as being the highest which at that time was considered reasonably safe for underground service, and also because the Niagara Falls Power Company had already adopted this as a transformed voltage for the transmission of power to some of its local customers.

Three-phase was taken instead of the two-phase winding of the American machines on account of the simplification of switches, wiring, etc., and also to effect the saving of 25 per cent. in transmission copper.

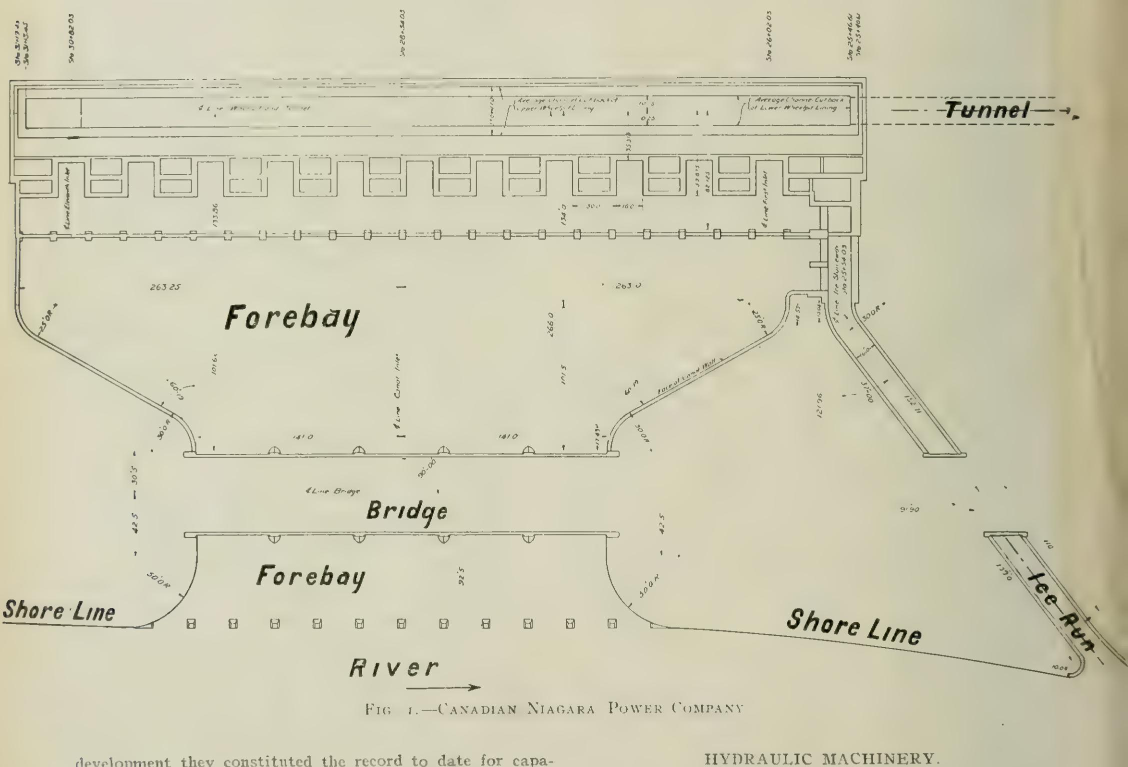


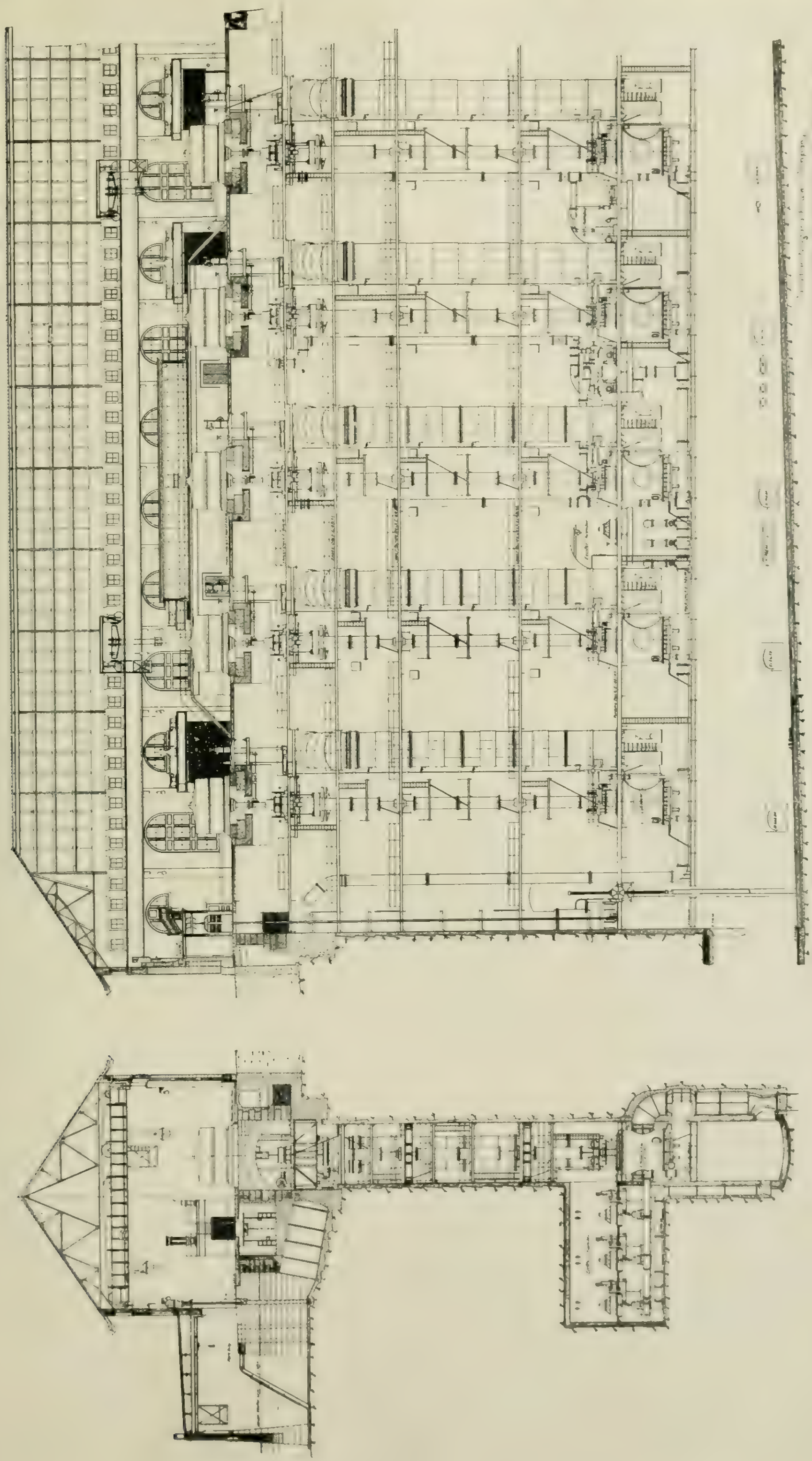
FIG. 1.—CANADIAN NIAGARA POWER COMPANY

HYDRAULIC MACHINERY.

The general hydraulic construction of this plant is very similar to that of the American plant, which is too well known to engineers to require detailed description here. Fig. 1 shows a general plan of the development. Fig. 2 shows sections of the power house and wheel pit, together with their equipment.

The turbines were all designed by Escher Wyss, and the first three wheels were built at Zurich. The last two were built from the same designs by the I. P. Morris Company, of Philadelphia. The turbines are of the Francis type, inward discharge, with draft tubes led to the bottom of the wheel pit, as shown in Fig. 2. A regulating gate is installed at the end of the wheel pit to maintain the level of the tail water at a sufficient height at all loads to cover the mouths of the draft tubes.

Paper read at Annual Convention of Canadian Electrical Association



SECTIONS OF POWER HOUSE AND WHEEL-PIT
SHOWING MACHINERY INSTALLED

FIG. 2 – CANADIAN-NIAGARA POWER COMPANY

This regulating gate is operated by an 85 h.p. direct current motor, hand controlled. The weight of the rotating machinery is carried by an oil thrust bearing under the dynamos, and also by an hydraulic piston at the bottom of the turbine. The turbines give an output of about 12,000 h.p. at full-gate opening at a head of approximately 135 feet.

ELECTRIC GENERATORS.

The generators are of the internal revolving field type with 12 poles giving 25 cycles at 250 revolutions per minute. The details of construction of the generator are shown in Fig. 3. The efficiency at full load is about 98 per cent., and the regulation on full non-inductive load about 8 per cent. The generators were built by the General Electric Company, a large part of the assembly work being carried out in the power house. The armatures are connected Y, and the neutral is brought out so that it can be grounded if desired.

SWITCHBOARD.

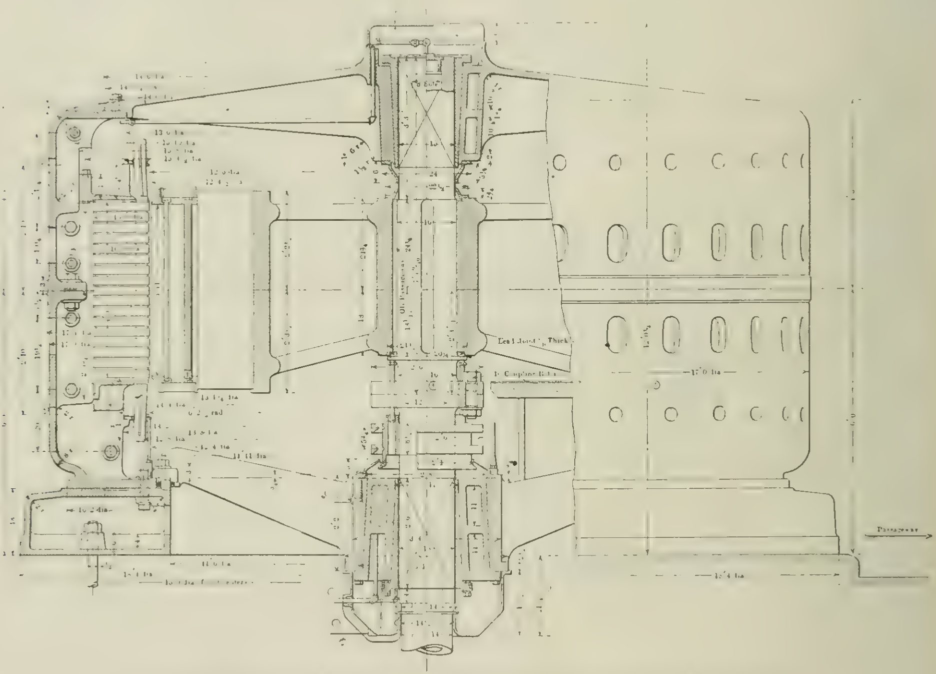
From the generators the current is led through varnished cambric insulated cables to double-throw selector oil switches, and thence to the bus bars, of which there are four sets. The oil switches are electrically operated by relay switches placed on the main switchboard panels. Fig. 4 shows a general section through the switchboard gallery, and indicates the relation between controlling panels, oil switches, bus bars, etc. Fig 5 shows a photograph of the controlling and instrument board. This operating board consists of five generator panels, 20 feeder panels, 10 recording wattmeter panels, and three bus bar interconnecting panels. Each panel is distinct, and contains no instruments or switches except those belonging to the particular feeder or generator in question. In this regard it is different from most of the switchboard arrangements adopted in modern plants. The so-called "bench-board" system of operation usually installed economizes space, but it has certain disadvantages. The concentration of instruments and relays necessitated in this construction may cause considerable confusion at times of emergency. If instrument needles suddenly begin to slam around on their scales it is somewhat difficult to make a prompt and correct association in a bench-board installation between the instruments and the relay switches involved, which are usually on slabs separate from the instruments. With the panel construction adopted in this plant, possibly more space is occupied by the board itself, but operating simplicity and directness results. Each panel contains within its limits all the instruments and switches involved in any operation which the attendant has to make, and consequently there is a minimum liability to confusion and mistake. The separate panel construction also permits the separation of control wires, which become so congested in the bench-board arrangement. In case of an accident in the power house there is consequently less likelihood of a complete crippling of the control system.

The present equipment of the power house comprises five machines, and this group and its switchboard is considered as a complete plant. When the power house structure is extended to its full length six more 10,000 h.p. units will be installed, having an entirely separate switchboard, separate exciter plant, etc. This separation is made for the reason that 50,000 h.p. is believed to be as large a block of power as should be under the control of a single switchboard and its attendant.

Fig. 6 shows the general wiring diagram of the circuits connected with the first five units.

EXCITER PLANT.

The exciter plant is located in a compartment near the bottom of the wheel pit at the turbine deck level. There are three 200 k.w. 125 volt d.c. generators, each connected to an independent turbine. Any two of these units will carry the entire direct current load of the power house. There are two sets of exciter bus bars, one of which operates the generator fields and the other the d.c. power system, including motors and arc lights. The current is carried up the pit to the main floor of the power house through a system of vertical copper bars supported every ten feet. Fig. 7 shows the general arrangement of this plant.



SECTION AND ELEVATION OF ONE OF THE 10,000 H.P. GENERATORS FOR THE CANADIAN NIAGARA POWER COMPANY

Fig. 3.

UNDERGROUND CABLE SYSTEM.

All the power from the power house is transmitted underground by means of 000 B. & S. paper insulated triplex lead covered cables. The feeders are divided into two groups. One set leads from the north end of the power house through Victoria Park and across the arch bridge to the plants of the Niagara Falls Power Company, with which they are interconnected. The other group runs south up the high bank above the power house to the transformer house there located.

The conduits are constructed in four groups of eight ducts each. The groups are segregated in order to separate the cables in the manholes, and consequently to reduce to a minimum the risk of damage from short circuit and

also to prevent overheating of the cables in the ducts, the separation of the groups facilitating the conduction of heat in the ground. In no case is the group wider than two ducts, so that every duct has the ground in contact at least on one face. The cables are rated at a maximum of 4,000 h.p. each at 12,000 volts. This rating corresponds to about a 40-degree C. rise in copper temperature when all the cables in the group are in service at full load.

Fig. 8 shows the general construction of manholes and grouping of ducts. The manholes are all made double with a concrete fire wall between the two halves, so that in case of a destructive manhole short circuit, not more than one-half the feeders could be involved. Fig. 9 shows the method of interconnecting the three-phase 12,000 volt Canadian system with the [illegible] volt two-phase system of the Niagara Falls Power Company through Scott

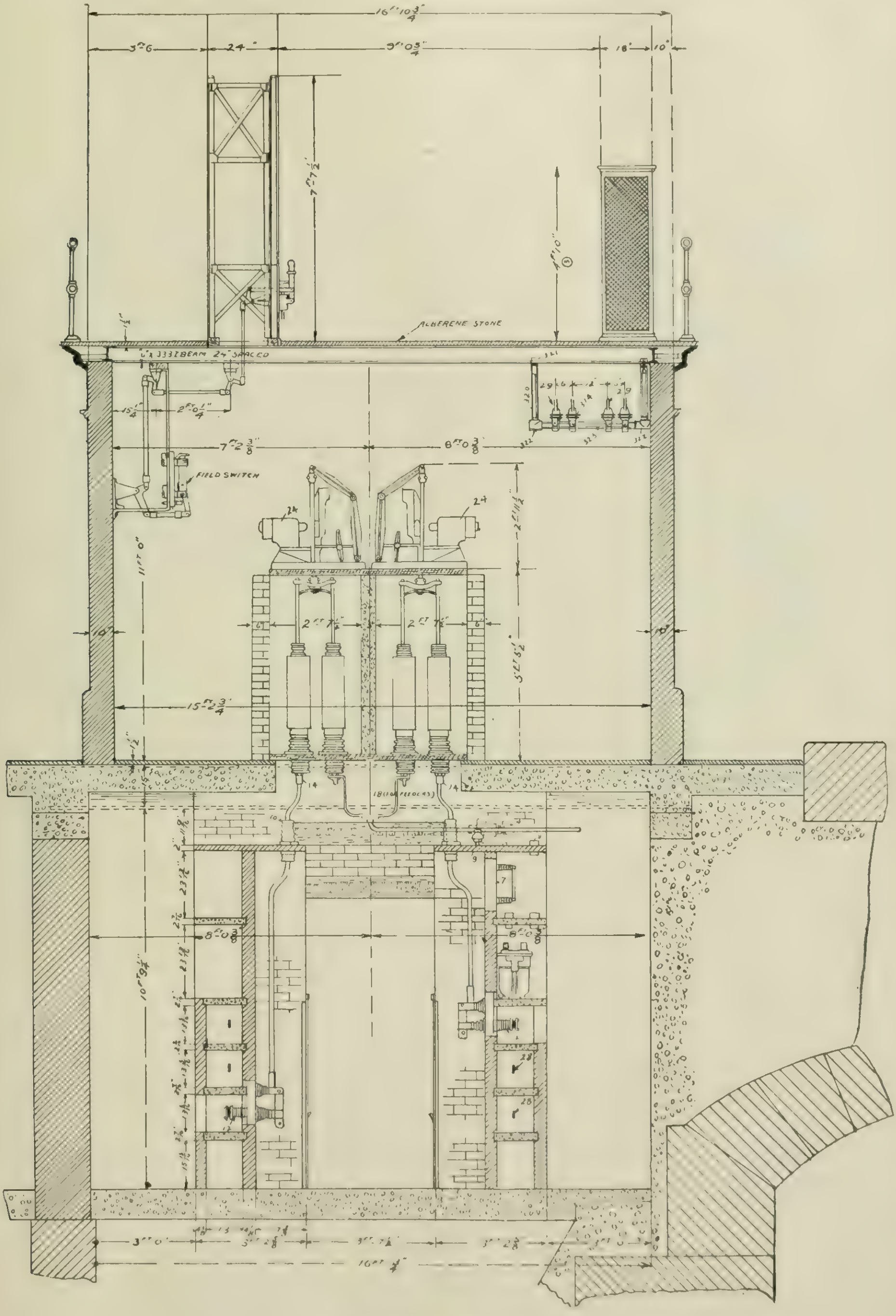


Fig. 4—Canadian Niagara Power Company.

connected transformers. The two systems are constantly in operation in parallel through this connection, and no trouble is experienced from pumping or in controlling the distribution of load.

TRANSFORMER HOUSE

Fig. 10 shows the general arrangement of the transformer house and its equipment. The installation comprises 12 1250-k.w. transformers, each bank therefore receiving one-half the output of a generator at the power house. Transformers of comparatively small size were installed for reasons of flexibility of operation. The very large transformer units now being used in some plants cost considerably less per k.w., but the large size of units makes it difficult to isolate circuits and bus bar sections so necessary at times in the operation of a plant. The

combinations of coils, as shown in the sketch, any of the following voltage ratios can be obtained with the full copper efficiency of each coil :—

12,000 volts △ to 24,000 volts △
12,000 volts _ to 36,000 volts _
12,000 volts △ to 41,500 volts Y
12,000 volts _ to 62,500 volts Y

The west bay of the building also contains 3,000 h.p. in air blast transformers, which lower the generated voltage from 12,000 to 2,400 for distribution of power to several small consumers in the city of Niagara Falls, Ont., to whom it would be unsuitable to deliver power at as high a voltage as 12,000 volts. This distribution at 2,400 volts is by an overhead line.

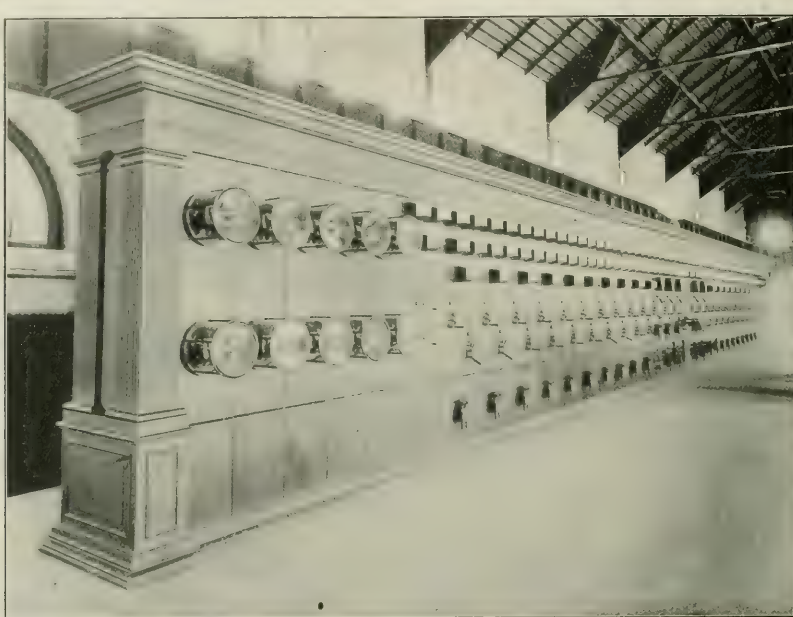


Fig. 5—Canadian Niagara Power Company.

building is divided into three sections. The east bay contains all the 12,000 switches and bus bars, the central bay contains only the step-up transformers, and the west bay the 60,000 volt-switching apparatus. The transformers are of the oil type, water cooled. The water supply is insured by a storage standpipe adjacent to the transformer house, which has sufficient capacity to operate the transformers for 48 hours in case of a water works shutdown. Fig. 11 illustrates the general scheme of connections of the transformer house circuits.

The arrangement of windings on the 1250-k.w. transformers are somewhat unusual. Fig. 12 illustrates the arrangement. The transformers are constructed with five similar coils, two of which constitute one winding and three the other winding, either of which set can be used interchangeably as primary or secondary. By the various

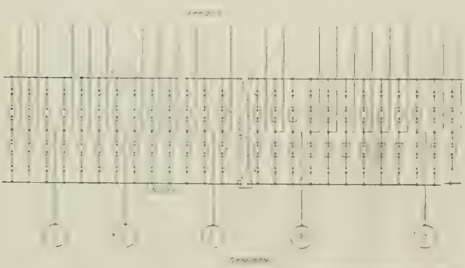


Fig. 6—Canadian Niagara Power Company.

All the high tension wiring in the transformer house is insulated for the highest voltage, 62,500 volts, and the conductors are of sufficient current carrying capacity for operation at full output at the lowest transformer voltage, viz. : 24,000 volts.

BUFFALO TRANSMISSION LINE.

The output from this transformer house will be used partially for transmission at 24,000 volts to Fort Erie, and thence across the Niagara River to Buffalo, the distance being about fifteen miles. There are some engineering features connected with this work which may be of interest.

The transmission line is built on a private right of way 30 feet wide extending from the transformer house to the river front at Fort Erie. There will be two pole lines on this right of way, each carrying two circuits. The circuits have a nominal rating of 12,500 h.p. each at 24,000 volts, making 50,000 h.p. total for the transmission. The poles used are shown in Fig. 13. They consist of two 4-inch wrought iron pipes, jointed together at the centre as shown by a casting which has four struts projecting radially at 90-degree angles. Truss rods secured at the top and bottom of the poles pass over the ends of these struts, which, when tightened up, stiffen the jointed pipe. The function of this central tubular member is to resist downward compression only. The horizontal stresses on the pole are resisted by four guy rods anchored in the ground with concrete guy stubs. There is one of these guys in each quadrant around the pole. Under the central member of the pole is placed a heavy block of concrete which carries the iron step for the central pipe and takes the thrust. All the castings are malleable. The cross-arms are made of channels of special section, and the pins are malleable castings secured through the cross-arms by nuts on the bottom.

This type of pole is very strong and very economical in iron. The central member is under direct compression only, and the guys are under direct tension, which stresses require the minimum amount of material to resist. There are no lapped joints to rust out, and the sections are all large enough to withstand considerable corrosion without weakening. The poles are 40 feet in height, and are placed apart at distances ranging from 250 to 300 feet. Fig. 14 shows a map of the transmission line right of way.

The insulators shown in Fig. 15 are made of a compound known as "electrose." This material is a very good insulator, is very strong mechanically, and is entirely free from cracks and other defects which are common in glass and porcelain. Similar insulators have been used on the Buffalo transmission lines of the Niagara Falls Power Company for the past three years, and they are the only insulators on those lines which have caused no trouble. It is impossible to shatter electrose insulators by stone throwing, and they will frequently turn a rifle bullet without being damaged seriously. The conductor used on this line is of aluminum of 500,000 c.m. in section and having 37 strands.

At Fort Erie the line is tapped by a connection to a local sub-station for the supply of power to that municipality. The line then rises from the standard 40-foot elevation to a tower 80 feet high, erected about 1,200 feet from the Canadian shore line of the Niagara River. Thence the line rises again by a single span of 1,200 feet to a tower on the river bank 210 feet in height. Thence by another single span of 2,300 feet the line passes to the Buffalo side of the river to another 210 foot tower. From there it drops down to a new 50,000 h.p. terminal house constructed for the distribution of this power in Buffalo.

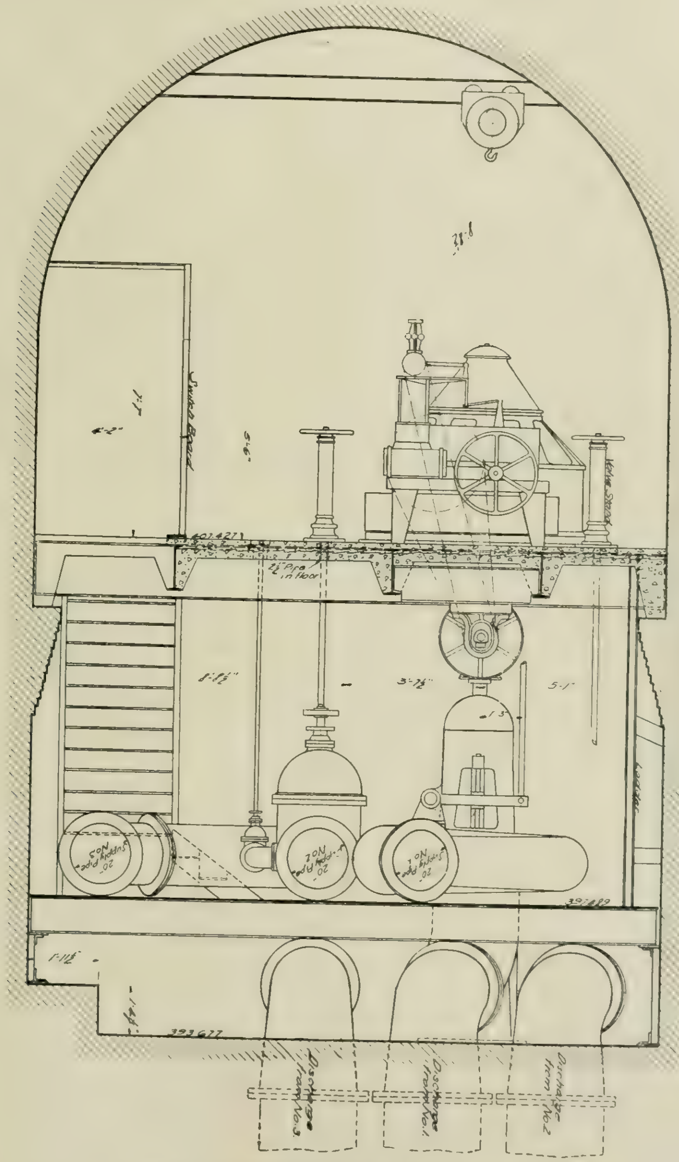


Fig. 7—Canadian Niagara Power Company.

Fig. 16 shows the general profile of this long span crossing, 500,000 c.m. 61 strand aluminum cable is used. Each wire is secured to the top of pole B to an insulated support. At towers A and C the lines are attached through strain insulators to steel cables, which pass over sheaves about 24 inches in diameter, and thence to weights which are equal to the tension on the wire in lbs. This amounts to 4,500 lbs. on each line The live portion of the line

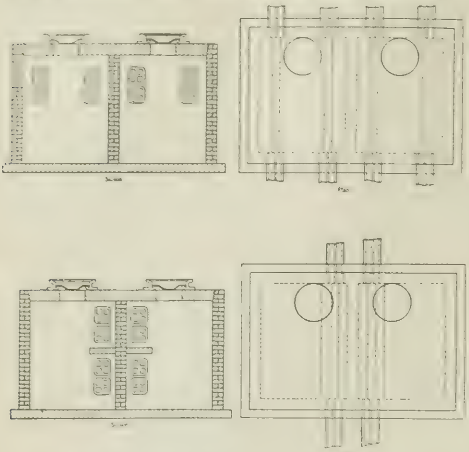


Fig. 8—Canadian Niagara Power Company.

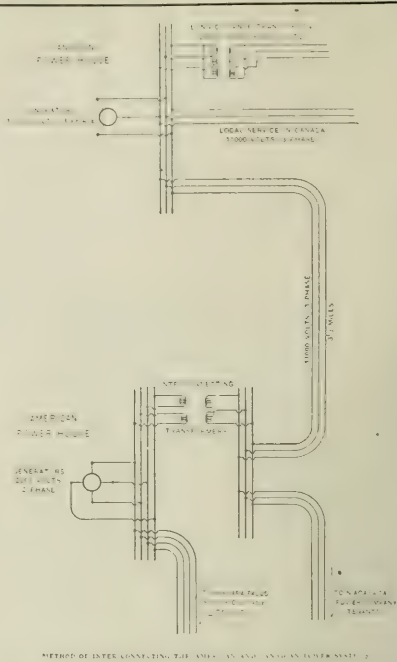


Fig. 9—Canadian Niagara Power Company.

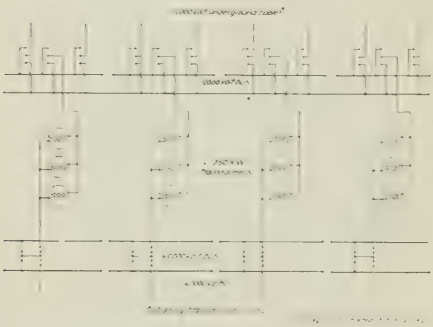


Fig. 11—Canadian Niagara Power Company.

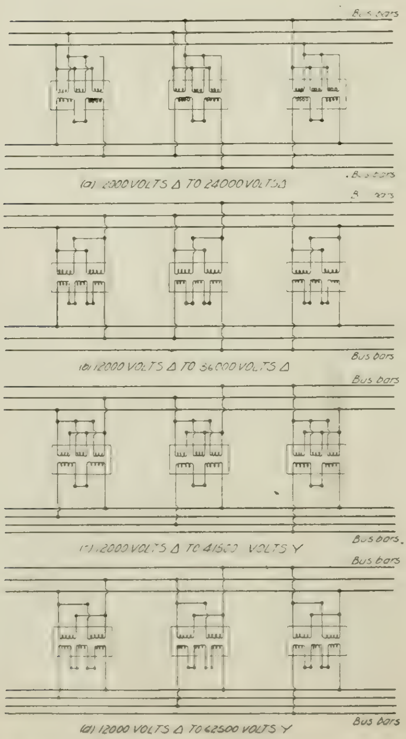


Fig. 12—Canadian Niagara Power Company.

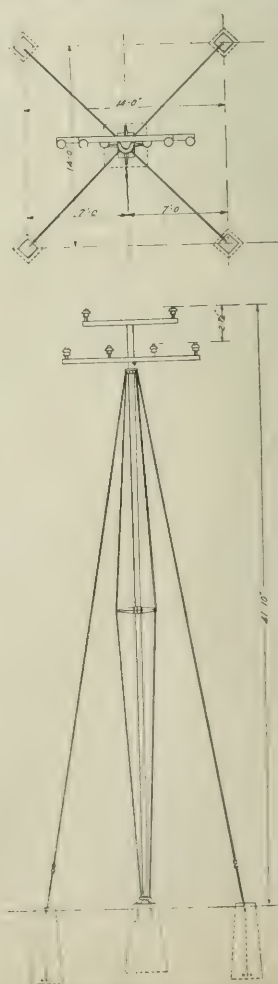


Fig. 13—Canadian Niagara Power Company.

passes down the tower from the outside of the strain insulator to the terminal house on the Buffalo side and to the main transmission line on the Canadian side.

The object of this arrangement is to obtain a maximum clearance above the water with a minimum height of tower. By keeping the span under constant tension the deflection becomes independent of variations in temperature and also independent of wind stress allowance. In a fixed span of this length the increase in deflection in summer due to the heat of the sun would amount to at least 40 feet. With the weight and sheave arrangement the deflection is maintained constant at the minimum. At times of heavy wind stress the weights will rise and prevent the tension in the cable from ever exceeding the predetermined amount equal to the balance weight.

The power house has been in successful operation for about a year, and five generators are now in service. The transmission lines to Fort Erie and Buffalo are now in process of construction, and are expected to be put in service about November 1st.

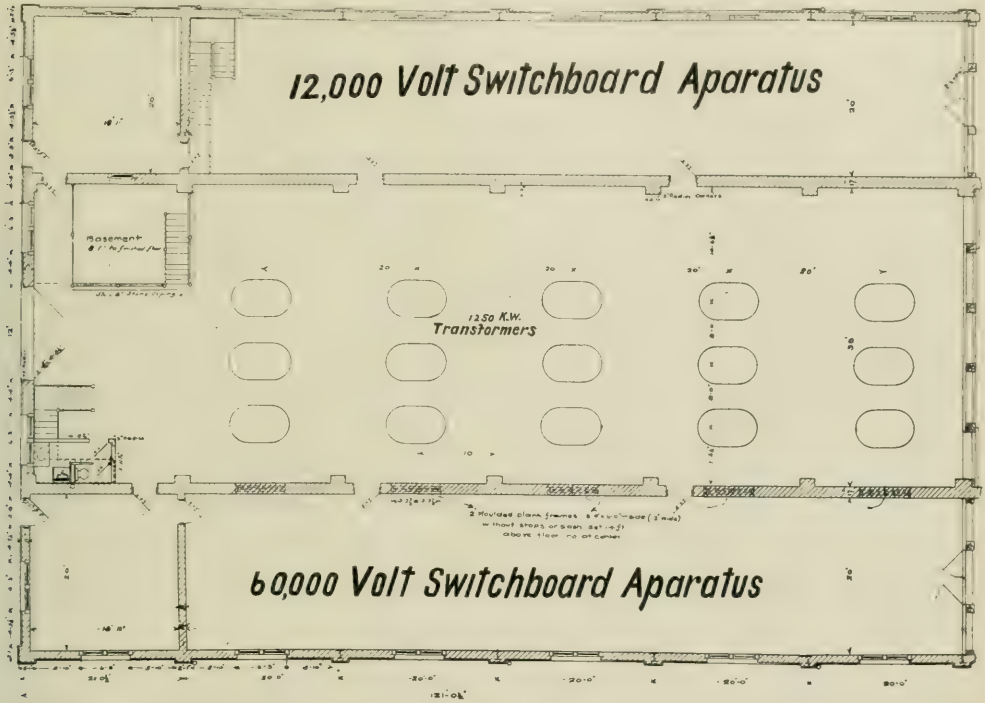


Fig. 10—Canadian Niagara Power Company.

Fig. 14—Canadian Niagara Power Company.

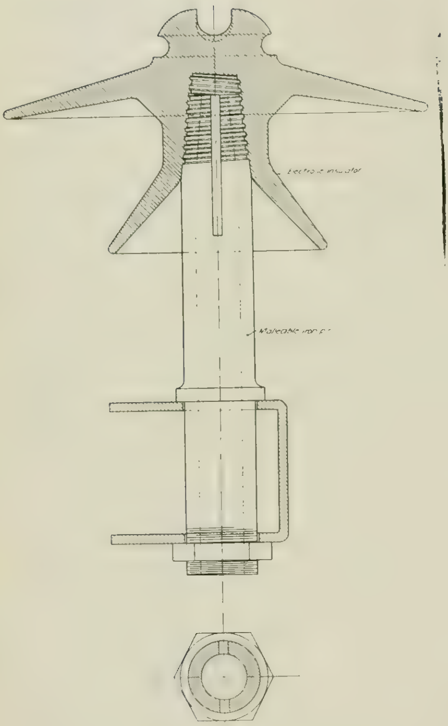


Fig. 15—Canadian Niagara Power Company.

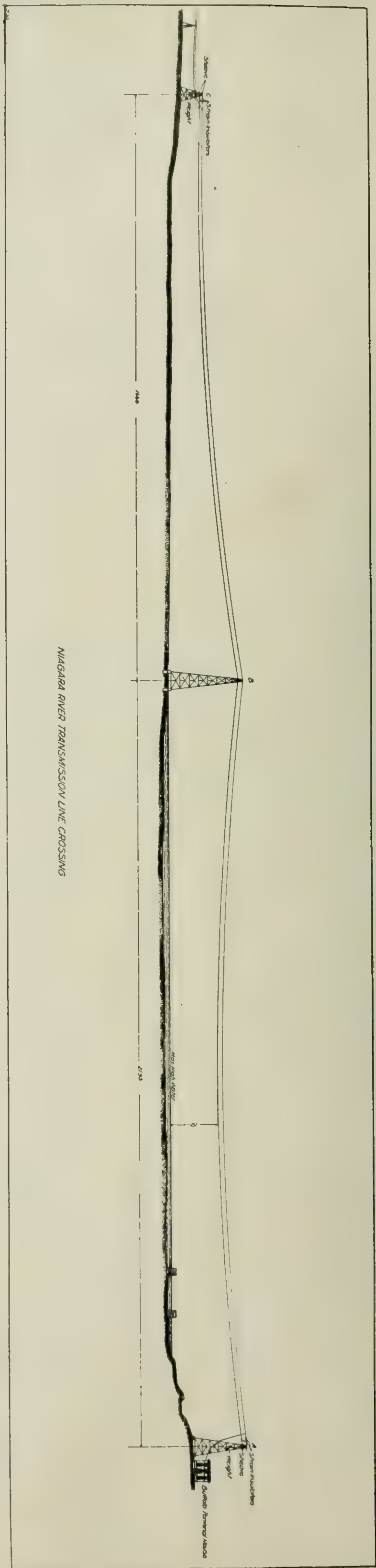


Fig. 16—Canadian Niagara Power Company.

THE POWER PLANT OF THE ELECTRICAL DEVELOPMENT COMPANY OF ONTARIO

By F. O. BLACKWELL

The power plant of the Electrical Development Company was designed to utilize 11,200 c.f.s. of water under a head of 135.5 ft. The water is diverted from the Niagara River at Tempest Point, midway between the headworks of the Ontario Power Company and the Canadian Niagara Falls Power Company.

The general plan of development adopted called for the construction of a wing wall to gather the water from the rapids, the excavation of a forebay of sufficient capacity with the river at its lowest future stage, a wheel pit, and a tailrace tunnel discharging under the centre of the Horseshoe Falls, where the flow of water over the Falls is greatest.

The forebay in the rapids and the tunnel outlet under the Falls were both bold and original conceptions, which were thought at the time to be practically impossible of execution.

In order to uncover the forebay it was necessary to construct a coffer dam 2,200 ft. long in the rapids, where, for a portion of the way, the cribs had to be sunk in water 26 ft. deep and running at a velocity of 22 ft. a second. This work was started in April, 1903, and proved to be an extremely difficult undertaking, but was successfully completed in about twelve months.

The tailrace tunnel was started in May, 1903, by the sinking of a construction shaft on the bank of the river 150 ft. deep and 15 x 7 ft. inside the timbering. From this shaft a drift 14 ft. wide and 7 ft. high was run 670 ft. to the portal of the tailrace tunnel, work upon which was only actually started in December of the same year. The final opening under the Falls proved very difficult on account of the large amount of water encountered near the face and the mass of detritus that had to be cleared away by men exposed to the full force of the wind and spray from the Falls.

The wing dam is 785 ft. long, and its maximum height is 27 ft. The elevation of the crest is 527 ft., and there will be from 3 to 8 ft. of water flowing over it, depending upon the condition of the river. Near the power house the dam is cut away for a length of 30 ft. to an elevation of 524 ft., so that there will be 3 ft. additional depth of water to carry away ice from the submerged arches in front of the power house. This question of guarding against ice is one of the most important problems which had to be met. In addition to the first line of submerged arches just referred to, a second wall has been constructed outside of the racks. The spaces between the outer and inner walls, and between the latter and the racks, are arranged each with a spillway at one end, so that such ice as passes through will float out at the north end of the building.

The wheel pit is 416 ft. long and 22 ft. in width inside of the brick lining, which is 2 ft. thick, and is spanned by masonry arches at three levels to carry the machinery. The ends of the pit are also closed by arched wall linings. The arches were not allowed to be put in until the pit had closed in as much as it would and come to rest. There has been no movement whatever at the union of the arches and the walls that the most accurate observations could detect, which is interesting on account of the theory once advanced that there was a periodic change in the distance apart of the sides of the pit.

For the power to be developed the length of the wheel pit is much less than in previous developments of this character. This is due to the penstocks alternately being on the right and left hand sides of the water wheels, permitting one hoistway to serve two wheels.

The water after passing through the racks enters a cast iron bell-mouth, which in turn joins on to a riveted steel penstock 10 ft. 6 in. in diameter.

There are 11 penstocks, and at the head of each there is an electrically operated gate to control the water. The penstocks are connected at the bottom to water wheels of 13,000 h.p. capacity, running at a speed of 250 revolutions per minute. The wheels and penstocks rest on a heavy concrete foundation, which covers the bottom of the wheel pit.

The hydraulic apparatus is being furnished by the I. P. Morris Company, of Philadelphia.

Each wheel unit consists of two Francis internal discharge turbines 5 ft. 4 in. in diameter. The discharge of water is to be governed by cylinder gates, and the weight of the moving parts will be partially taken by a water piston in the wheel. There is a single cast iron draft tube 9 ft. in diameter for each wheel, and the units alternately discharge water underneath the east and west tailrace tunnels. The object of the under discharge is to seal the draft tubes and prevent loss of vacuum, no matter what the elevation of the water in the tunnels may be, and without the necessity for a tailrace weir. By using two tunnels it is possible to shut off the water entirely from one-half of the wheels without interfering with the other half. By closing down the wheels, discharging water into either tunnel, that tunnel will drain itself, and there is no necessity for closing off the mouth of the tunnel. A gate is provided at the mouth of both tunnels, however, in case of extreme back water, which has been known to be 50 ft. above normal in the lower river.

As the wheel pit is not connected to the tail race, the hydraulic apparatus can never be flooded out.

The tunnels on each side of the wheel pit are 25 ft. deep, and vary in width from 66 to 30 ft, with a velocity of from 15 to 21 ft. a second. At a point about 150 ft. north of the wheel pit the tunnels come together. At the junction the tunnel is 35 ft. wide and 25 ft. 6 in. high and tapers to a width of 23 ft. 5 in. and a height of 26 ft. 13 in., which section is carried to the edge of the Falls, a distance of 1,935 ft. The slope of the main tunnel is .005, making the total loss about 10 ft., and the velocity is 26 ft. a second. The tunnels have a lining 2 ft. thick throughout of concrete faced with brick, except for 300 ft. at the north end, where the lining consists of concrete rings in 6 ft. sections, which are expected to break off as the Falls gradually wear away. This is necessary, as the crest in the centre has been receding at an average rate of 2 1-2 ft. a year.

The power of the water wheels is delivered to the electric generators through vertical shafts 150 ft. long, consisting of riveted steel tubes 30 inches in diameter between bearings and solid shafts 14 1-2 inches in diameter at bearings. This shaft is held at three points in the wheel pit by steady bearings resting on concrete arches. At the upper end there is an oil thrust bearing 37 1-2 in. in diameter fed by oil under a pressure of 350 lbs., which is sufficient to carry the weight of the entire revolving parts should the water thrust fail from any cause.

There will be ultimately eleven 8,000-k.w. generator units, four of which are now being installed by the Canadian General Electric Company. These are of the revolving field type and run at a speed of 250 r.p.m. They deliver three-phase alternating current at a periodicity of 25 cycles and a potential of 12,000 volts. There are at first to be two 500-k.w. water wheel driven exciters in a room underground, and two motor-generator sets of the same capacity on the generator floor. Eventually three sets of each type will be installed, any two of which will excite all the alternators.

The controlling switchboard for the entire plant, including transformers and transmission lines, is located in the centre of the power house, where the operator can see the generators. It consists of an enclosed compartment with a bench-board in front and doors at the ends. The instruments which are ordinarily employed in the operation of the station face towards the generator room. On the back are the recording instruments and switches, which are only occasionally used or referred to. Dummy bus bars and signal lamps on the bench-board clearly indicate to the operator the connections in the station, and the instruments are so located that each is over the switch which controls them. The generator instruments, for instance, are over the generator control switch. The board is so compact that an operator standing in front of it can see all the instruments from one position, and can conveniently reach all the controlling switches. The power house bus bars, generator oil switches, instrument and switch transformers are located immediately below the power house floor in brick compartments. The wiring arrangement is such that a generator can either be con-

Paper read at Annual Convention of Canadian Electrical Association.

nected to the bus bar or to a separate outgoing cable. In ordinary operation the current from each generator will leave the building by the shortest possible route, and there will be practically no cables running the length of the power house.

The power house will be a handsome building in the style of the Italian Renaissance, about 500 ft. long and 70 ft. wide. The height will be 40 ft., except at the centre and end bays. The centre bay will stand out from the face of the building, and, besides being the main entrance, will give room for the offices of the Power Company. On the inside it will also afford space for the switchboard and auxiliary apparatus. The power and transformer houses are 1,817 ft. apart, and will eventually be connected by four underground conduits. One conduit will be in reserve, and the plant will not be crippled unless two conduits should simultaneously fail.

At present two conduits only are constructed, each with sixteen 4 1-4 inch ducts placed two wide and eight deep. The manholes are common to the two conduits, but are divided into two parts by a central partition, so that one duct system would not be damaged by a burn-out on the other.

The cables required for the portion of the power plant first installed are six 500,000 c.m. triplex for 12,000 volt power, two 00 B. & S. for the switch motor bus bars, two with 45 No. 8 B. & S. wires for oil switch control, two each of 13 No. 12 and 14 No. 7 wires for instrument connections. The cables are in duplicate, and either half of the ducts might be disabled without shutting down the power system.

The transformer house is on top of the bluff outside of the Park limits, and is designed to accommodate fifteen 2,670-k.w. transformers furnished by the Canadian General Electric Company, twelve of which are now being installed. These transformers are of the oil-immersed, water-cooled type, and are wound for 10,000, 11,000 and 12,000 volts primary and 60,000, 50,000 and 40,000 volts secondary. They will be connected in delta on both primary and secondary sides.

Each transformer is placed in a separate closed fireproof room, so as to minimize the fire risk and prevent the possibility of trouble in one transformer being communicated to others. The transformers are mounted on rails and arranged to slide out of the compartments into a gangway, where they can be readily handled by an overhead travelling crane.

The piping for oil and water is placed in the basement under the back of the building and on the wall of the transformer compartments.

The cables from the power house are carried in ducts to a gallery above the transformers, where the 12,000 volt switches, instrument transformers and bus bars are located.

The high potential bus bars, wiring instrument transformers and air switches for the 60,000 volt circuits are located in the room back of the transformers, and connected through the gallery floor to the high potential oil switches on the floor above.

The outgoing transmission lines leave the building through porcelain bushings at the back, and are protected by lightning arresters on the wall below.

The wiring throughout is completely enclosed in brick compartments, the only openings being through asbestos doors placed at points convenient for inspection.

The transmission line to Toronto, constructed by the Toronto and Niagara Power Company, is built on a private right of way 80 ft. wide, which can later be used for a double-track railway. With this idea in view, the line was located so that the maximum grade at no point need exceed one per cent., and the minimum radius of track curvature can be made as low as a quarter of a mile.

Two complete steel tower transmission lines will eventually be constructed, one only being erected at present. Each tower carries two circuits of 190,000 c.m. copper conductor. The standard distance between poles is 400 ft., although much longer spans are used in crossing rivers and ravines. For curves and long spans special extra heavy towers are employed, with double and triple insulators. The height of the standard tower is sufficient to support the lower cable at a height of 40 ft. from the ground. Fifty and sixty-foot towers are made by bolting extensions to the bottom of the standard towers, and are used wherever there are depressions along the right of way. In two places towers 150 ft. and 175 ft. high are required in order to cross navigable channels at the Welland Canal and at Burlington Beach.

The copper cable consists of six strands with a hemp centre, and has a tensile strength of 60,000 lbs., and an elastic limit of 40,000 lbs. per square inch. It was made by the Dominion Wire and Cable Company, of Montreal.

A large portion of the power is delivered to synchronous apparatus, the Toronto Street Railway employing rotary converters, and the Lighting Company synchronous motor-generator sets. The loss of power, when transmitting 10,000 h.p. to Toronto over each circuit, will be less than 10 per cent., and either line can transmit 20,000 h.p. with less than 20 per cent. loss should the other become disabled.

The insulators are 14 in. in diameter and 14 in. high, and are tested for a potential of 120,000 volts complete, or 60,000 volts on each of the three parts of which it is composed.

The transmission towers are heavily galvanized after all machine work upon the parts has been completed. They were made by the Canada Foundry Company, of Toronto, and the Riter-Conley Manufacturing Company, of Pittsburg, Pa. At points exposed to severe lightning the line will be protected by 12 ft. extensions carrying galvanized steel cable above the power conductors.

There will be three division houses along the line, dividing it into four sections, any one of which can be cut out for inspection or repair. The length of the line is about 90 miles, and the division houses will therefore be 22 1-2 miles apart. A lineman will control each section daily after the transmission is in operation.

The sub-station in Toronto is designed for fifteen 2,670-k.w. transformers, and is similar to the transformer house at Niagara Falls, except that there will be double low-tension bus bars and a much larger number of feeder cables for distributing power throughout the city of Toronto.

The switchboard is located at one end for controlling the transmission lines, transformers and 12,000 volt circuits. This is equipped with dummy bus bars with all necessary instruments.

In the plans of the Electrical Development Company every effort has been made to avoid any interruptions to the power service. No single accident or any probable combination of accidents is ever likely to shut down the entire plant. The double ice protection, twin tailrace tunnels, the extra 8,000-k.w. water wheel, generator and transformer unit, and the duplication of the transmission lines and of all auxiliary apparatus is with this end in view.

The engineering design of the plant is in charge of Dr. F. S. Pearson as consulting engineer. The water power development was planned by Mr. H. L. Cooper, chief hydraulic engineer, and the writer laid out the electric plant. The construction of the hydraulic work and power house was originally under Mr. Beverly R. Value, and is now in charge of Mr. L. J. Hirt as resident engineer, and Mr. Walter Pearson as electrical engineer.

The transformer houses and transmission line were built by Mr. Robt. C. Brown, chief electrical engineer of the Toronto and Niagara Power Company.

THE CANADIAN McVICKER ENGINE.

In this number we have pleasure in announcing the establishment of a new Canadian business for the manufacture of gas and gasoline engines at Galt, Ontario. The new company is known as The Canadian McVicker Engine Company, Limited. This company owns the patent rights covering the McVicker automatic gas and gasoline engine, an engine which is said to have had phenomenal success in the United States during the past three years as manufactured by the Alma Manufacturing Company, of Alma, Michigan.

The engine was invented by W. J. McVicker, of Omaha, Nebraska, in 1902, and is being built by the Alma Manufacturing Company and by the Canadian McVicker Engine Company, Limited. The latter company at Galt, Ont., is directly associated with the parent company at Alma, Mich., and is its Canadian representative.

The manufacturers claim that the McVicker engine marks a decided advance in gas engine construction, an advance that may even be termed a revolution. Not only is it said to be simpler, having one-third the number of parts of other makes, but it has no cams, gears, eccentrics, trigger work or complicated parts so apparent in other makes, and is the only four-cycle engine of a single cylinder that will run in either direction. The governor is claimed to be ten times as sensitive as that of any other engine, the governor being attached to the fly-wheel and operating by cutting off the spark instead of working mechanically and operating valves.

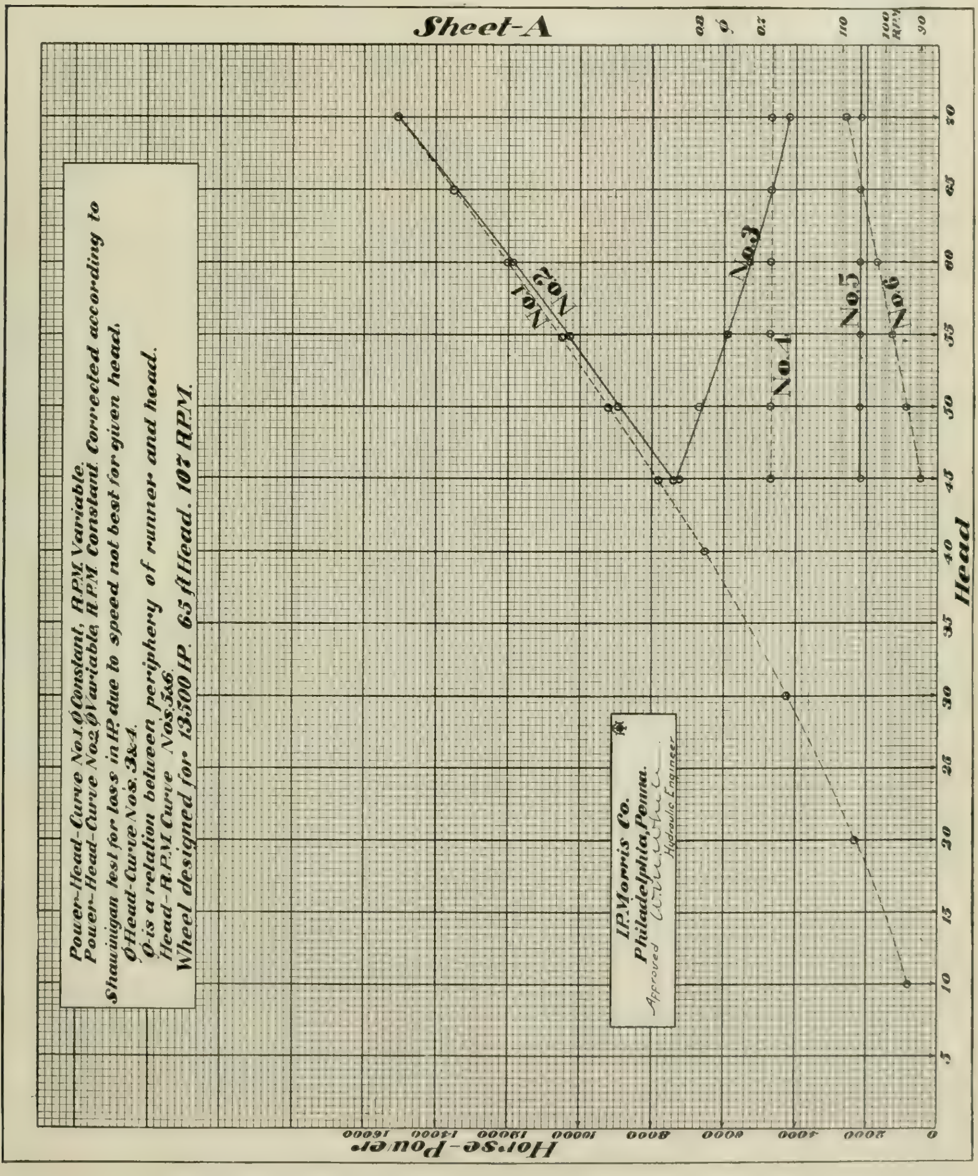
This engine, it is claimed, will stand fifty per cent. overload without slacking. Another feature is the automatic device used to open the exhaust by the waste energy from the explosion after the piston has travelled the length of its stroke.

The Alma Company are building six engines per day and are now enlarging their plant to immediately double its capacity. From the beginning the Alma Company has found it impossible to fill its orders. The engine is made in various types: stationary, to be used by farmers and manufacturers, and portables, in single and double cylinders for farm use and for threshing; also in the form of a double cylinder traction for threshing and ploughing. The engine is automatic in its action, simple to run, durable and efficient.

The industry's Canadian career dates from the first of this month. We wish for the Canadian business the success which has attended the efforts of the parent company in Alma, Michigan.

Variation in Power and Efficiency of a Turbine Wheel

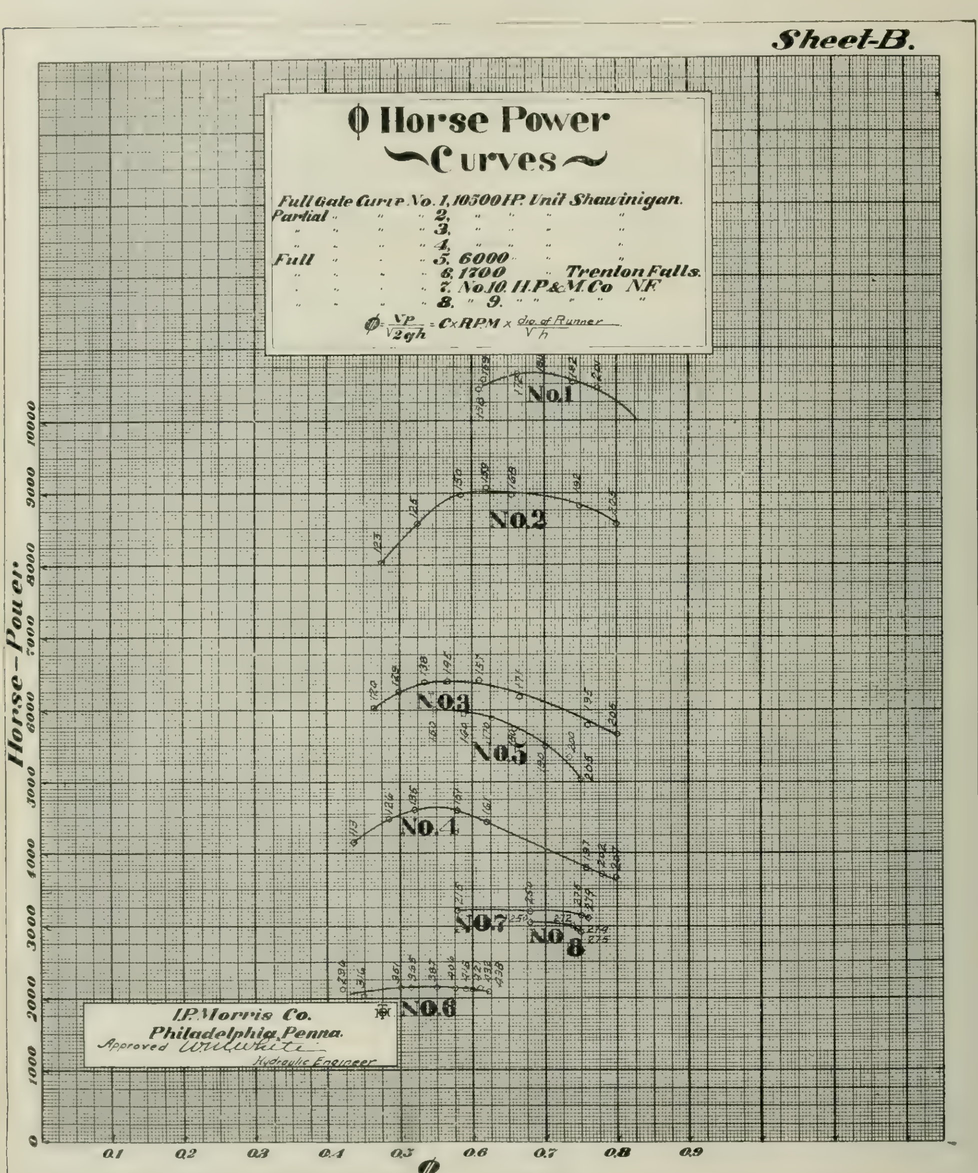
To those contemplating the utilization and development of water power, and especially to those making a study of the economic operation of water wheels, the accompanying curves will be of interest and value. They show the variation in power and efficiency of a turbine designed for one special load when running at a constant number of revolutions and operating under varying heads The curves are based upon the results of tests of wheels designed, built and installed by the I. P. Morris Company, of Philadelphia, and applied to the preliminary design of a 13,500 horse power wheel working under variable heads of from 50 to 70 feet, and running at a constant speed of 107 revolutions per minute.



Curve No. 1 on sheet A shows the power which the wheel will give for heads varying from 70 feet to zero, provided that the revolutions are allowed to vary as the square root of the head. The horse power of a given wheel will vary as the three-halves power of the head and the efficiency will remain constant, provided the revolutions are also permitted to vary to best suit the conditions of head. It will be noted from Curve No. 1 that at the 70 feet head the wheel would develop 15,000 horse power, and from the accompanying Curve No. 6 it will be noted that the best speed for the wheel under the conditions of 70 feet head will be 111 revolutions per minute. It will also be noted from Curve No. 1 that under the 50 feet head the wheel

would develop 9150 horse power if it be run at 94 revolutions per minute. By keeping a constant ratio between the peripheral speed of the runner and the square root of the head, the efficiency of the wheel at varying heads is not changed for any given setting of the gate. This ratio, which we have denoted by ϕ, is usually about 0.7 for reaction wheels.

This wheel was designed for 10,500 horse power when working under a head of 135 feet and when running at 180 revolutions per minute. The observations which are plotted on this curve were obtained by using the generator as a brake for the wheel, and a water rheostat was used as a means of loading the generator. The speed was then adjusted to 180 revolutions per



In order to properly utilize the output of the wheel, it is necessary that the speed be kept constant. In order to determine the amount of power that will be lost by keeping the speed constant while the head varies, the curves on sheet B were plotted from actual observations.

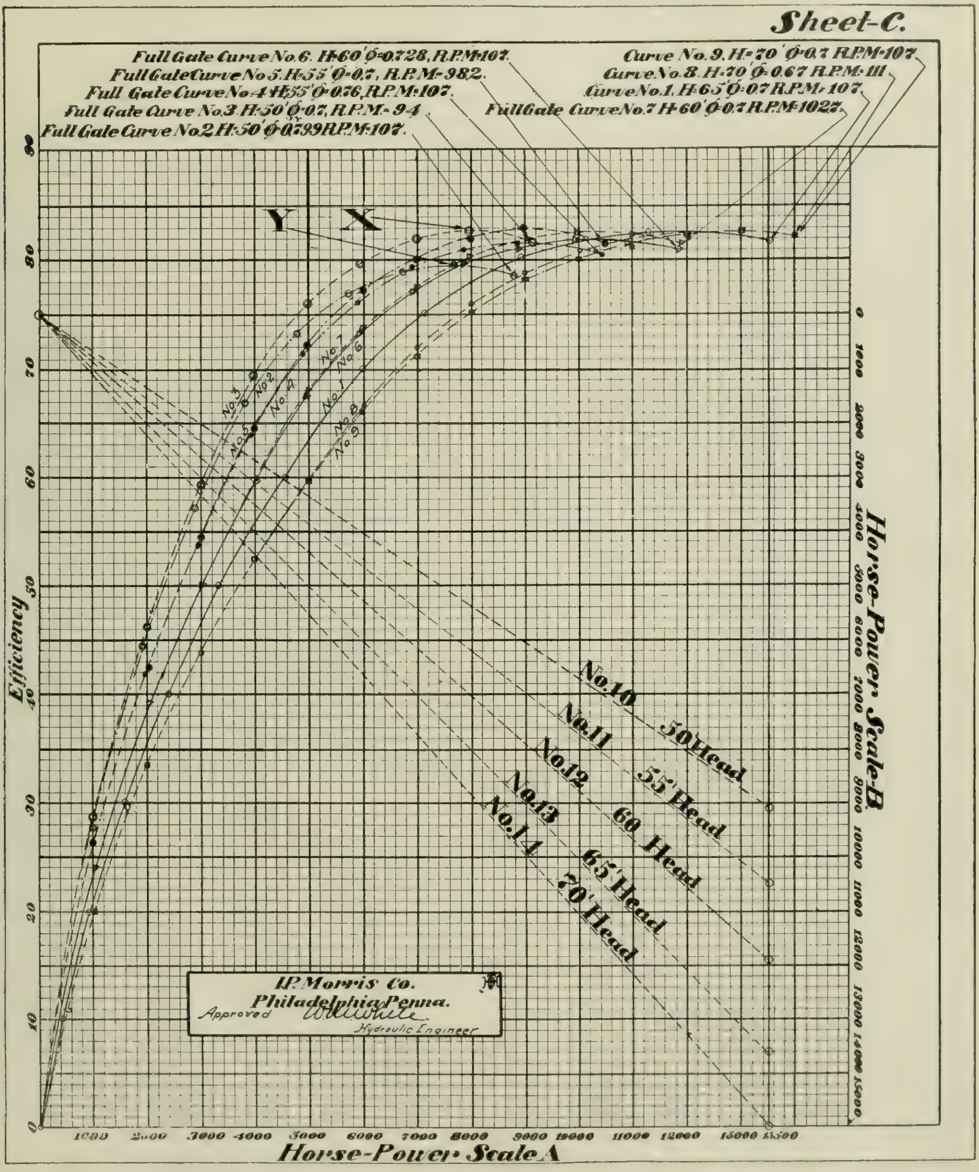
Curve No. 1 is the full gate reading of the 10 500 horse power turbine installed for the Shawinigan Water and Power Company, Shawinigan Falls, Que.

minute at the wide open gate and an observation made. By varying the field of the generator, the speed of the unit was varied without materially affecting the power and without moving the gate of the wheel. Observations were made above and below the normal speed through as wide limits as the rheostat in the field circuit of the generator would permit. The power output was determined by means of accurately calibrated electrical instruments. The speed was determined by

an accurately calibrated tachometer. The curves on this sheet give the relation between ϕ and horse power.

Referring back to sheet A and taking the 50 feet head conditions, we note that for a constant speed of 107 revolutions per minute ϕ would have to increase to 0.8. By referring again to sheet B, we note that when ϕ was 0.8 with full gate opening the power dropped from 10,000 horse power to 10,250 horse power, or about 3 3/10 per cent. Reducing the power at the 50 feet head on sheet A., Curve No. 1, by 3 3/10 per cent., we obtain a point on Curve No. 2 which gives the actual power which would be developed by the wheel under the 50 feet head, and running at the constant speed of 107 revolutions per minute. Curve No. 2 is plotted in this manner from Curve No. 1.

As a check to Curve No. 1 on sheet B, Curves Nos. 5, 6, 7 and 8 were plotted, all of which were made from actual observations, in the same manner as Curve No. 1. All of these wheels are Francis inflow and were designed for ϕ equal to 0.7 except curve No. 6, which is designed for ϕ equal to 0.5. No. 6 is an outward flow Fourneyron wheel. Curve No. 5 is for a 6000 horse power wheel with gates in the draft tubes.



The shape of the curve shows that the gate was probably not entirely open when the observations were made.

On sheet C are plotted efficiency curves which the designed wheel would give under varying heads and running at a constant number of revolutions. Curve No. 1 is an exact duplicate of the efficiency curve which obtained on a 3500 horse power wheel working under 210 feet head and making 250 revolutions per

minute. The test of this wheel was made by the engineers of the Niagara Falls Hydraulic Power and Manufacturing Company. The observations were carefully made and the results accurately determined. The water flowing from the wheel was determined by means of a weir constructed in the tail-race. The weir was arranged with end contractions, and the Francis formula was used in determining the quantity of water flowing. The power output of the wheel was determined by using the generators as a brake on the wheels. The power output from the generators was determined by accurately calibrated electrical instruments. The summation of these readings divided by the efficiency of the generator gave the power output at the flange coupling of the turbine shaft. The factory tests of the efficiencies of the generators were taken as correct. The wheel is of the Francis inflow type, with double runners, fitted with movable guide vanes. It will be noted that the efficiency of the wheel reaches 82 3/10 per cent. at about seven-eighths power, the efficiency dropping to 81½ per cent. at the wide open gate. It will be noted that the efficiency is very high at part load. This was accomplished in the design of the wheel by sacrificing the maximum efficiency which could be reached in order to obtain a higher efficiency at part loads. This curve was taken as typical of the efficiency which would be obtained by the wheel proposed to be built when working under a 65 feet head.

Curve No. 1 was plotted on Sheet C by assuming that at wide open gate 3,500 horse power corresponded to 13,500 horse power in the designed wheel. The part gate points of the curve were obtained by proportion. Curve No. 3 represents the efficiency and power of the wheel when working under 50 feet head and at 94 revolutions per minute.

Point A on this curve was obtained in the following manner: First, we read on Curve No. 1, Sheet A, the power which the wheel would give under the 50 feet head, and revolutions best suited. This we find to be 9,150 horse power. On Scale B, Sheet C, we draw a line from 9,150 horse power to zero, forming Curve No. 10. To find what the efficiency would be at 8,000 horse power under the 50 feet head, we take the point at 8,000 horse power on Scale B, projected horizontally until it intersects Curve No. 10, and we read 11,800 horse power. This point we project vertically until it is over 8,000 horse power on Scale A. Thus we obtain the Point A on Curve No. 3, which reads the efficiency of the wheel when developing 8,000 horse power under the 50 feet head and running at the revolutions best suited, namely, 94. We desire to run this wheel, however, at 107 revolutions per minute, under all conditions of head, and it is necessary to correct Curve No. 3 for the drop in power and efficiency due to the increase in speed.

Referring to Curve No. 1, Sheet A, we note that the power varies when the speed varies, and in the calculations of efficiency on Sheet C it has been supposed that the efficiency varies directly as the power. In other words, we have supposed that the quantity of water does not vary when the revolutions are changed with the constant setting of the gate. This is not strictly true, however, but for the observations as plotted on Curve No. 1, Sheet B, the quantity of water would probably vary one-half of one per cent., increasing as the revolutions decaease, and decreasing as the revolutions increase (from 158 to 201).

Referring to Sheet A and the 50 feet head, we note that when the speed is increased from the best speed of 94 revolutions to the desired speed of 107 revolutions the power falls 3-3/10 per cent., and the power and efficiency of the points on Curve No. 3 are decreased 3 3/10 per cent., resulting in Curve No. 2, which gives the desired curve for the operation of the wheel under 50 feet head and 107 revolutions per minute.

Referring to sheet B, Curves Nos. 1, 2, 3, and 4, it will be noted that the slope of these curves between ϕ equaling 0.7 and ϕ equaling 0.8 is about the same, and we can, therefore, reduce the power and efficiency of the points on Curve No. 3 by the same percentage, namely, 3 3/10 per cent. In this manner we obtain Curve No. 2, which gives the power and efficiency of the wheel when working under the 50 feet head, and running at the speed of 107 revolutions per minute. In this same manner Curves Nos. 5 and 7 are plotted, Curves Nos. 4 and 6 being deduced therefrom respectively. In the same manner Curve No. 9 is plotted and Curve No. 8 deduced therefrom. It will be noted that Curve No. 8 lies on the opposite side of the parent curve to that of the other curves. Curve No. 8 crosses Curve No. 9 at 13,500 horse power on Scale A, and beyond this point would drop below Curve No. 9. The reason Curve No. 8 falls to the left of Curve No. 9, and shows greater efficiency at part gate for the 70 feet head, is because when ϕ changes from 0.7 to 0.65 (on sheet B), the partial gate Curves Nos. 2, 3 and 4, sheet B, show the increase in power and efficiency. These points, however, cannot be very definitely determined, but it does show that the designed wheel, working under the head of 70 feet, and running at 107 revolutions, will show higher percentage of efficiency at part gates than when running at the 65 feet head and the same powers.

The curves on sheet C show that the efficiency is not seriously affected by keeping the speed of the wheel constant under the varying conditions of head. They do show, however, that the power is seriously affected under the varying head. The endings of the various curves show the maximum power, as read on Scale A, which the wheels will give under that head.

These curves, therefore, give the performance of the wheel when running at a constant number of revolutions and working under varying heads from 50 to 70 feet. The curves, of course, are not absolutely correct. They show, however, fairly accurately, the amount of variation in efficiency and power which may be expected from the actual conditions obtained with the proposed wheel under the head for which it was designed.

Mr. Frank Elliott has purchased the electric light plant at Winchester, Ont., and intends making a number of improvements. He has also introduced a new shedule of rates for lighting.

The Montreal Light, Heat & Power Company are erecting a new office building on the northwest corner of Craig and St. Urbain street. The building will consist of seven stories and a basement, and will be of skeleton steel construction, absolutely fire proof, and of exceedingly handsome appearance. It ist he intention of the company to occupy the three lower stories and the top story exclusively, renting the other stories for office purposes. The building is to be ready for occupation by May 1st, 1906.

POWER DEVELOPMENT AT SOULANGES CANAL.

There will be some noteworthy features in connection with the power house which the Montreal Light, Heat & Power Company are erecting near lock 4 of the Soulanges canal. Having drawn power from the Lachine rapids, four or five miles away, the Chambly rapids on the Richelieu, about 17 miles, and the Shawinigan Falls, on the St. Maurice, 86 miles, they are now engaged in making the St. Lawrence, about 40 miles away, tributary to the needs of the city.

At Soulanges the company will have, in the hydraulic development, for which Allis-Chalmers-Bullock, Limited, of Montreal, have the contract, the first plant of such capacity and class to be designed and built on this continent.

The principal turbines, three in number, will each be capable of delivering 5,350 brake h.p. on the shaft, under a head of 50 feet. Each of them will drive a 3,750 k.w. generator and will be provided with oil

MR. H. W. BUCK,
Chief Electrical Engineer Canadian Niagara Power Company

governors for the regulation of the speed. There will also be two smaller turbines developing each 300 h.p. to operate the electrical exciters. Heretofore it has been necessary to go to Europe for such high-class work. The company is making provision in the power house for the installation of a fourth unit of the same capacity, when it will be required.

In another respect, also, the plant will be unique, as the draft tubes for the larger units will be moulded in concrete. It will be the first construction of this kind in the country. The wheel-chambers will be built in concrete and the roadway along the canal will pass over them. It is claimed that with concrete the necessary curves in the tubes can be made so as to cause less friction than with the ordinary steel or iron penstocks and that, therefore, greater power can be developed from the falls at the command of the company.

Contracts were awarded last month for the construction of the Brantford and Hamilton Electric Railway, as follows: Ties, Manitoulin Lumber Company, Windsor; steel rails, Dominion Steel Company; electrical equipment, Canadian Westinghouse Company. Mr. I. C. Pearson has been appointed chief engineer for the building of road.

MARITIME ELECTRICAL ASSOCIATION.

The summer convention of the Maritime Electrical Assosiation was held, as announced, at Sydney, C.B., July 18, 19 and 20, and was very successful. On Wednesday morning an address of welcome was delivered by His Worship Mayor Fullerton, to which the president, Mr. P. R. Colpitt, replied. The afternoon was spent in inspecting the plants of the Dominion Iron & Steel Company, followed by a trip up the Sydney river. In the evening Mr. C. C. Starr, local manager of the Canadian Westinghouse Chmpany, entertained the delegates at a smoker in the Sydney Hotel.

Thursday forenoon was devoted to the reading o papers. Prof. Dahl read an interesting paper on "Wind Power as Applied to Electricity", and Mr. A. F. Townshend, manager of the Cape Breton Electric Company, spoke on the subject of "Auxiliary Business to be Obtained by Electric Companies through Electric Heating, Fans, Charging Automobiles with Mercury Arc Rectifier, etc." In the afternoon a trip was made to North Sydney and Sydney Mines to inspect the works of the Nova Scotia Steel & Coal Company.

At Friday morning session Mr. J. H. Winfield read an instructive paper on "The Evolution of the Telephone," and the report of the commitee on "Pole Rentals" was discussed. Special cars conveyed the delegates to Glace Bay in the afternoon for the purpose of visiting the municipal electric light plant and the colleries of the Dominion Coal Company, and a banquet was held at the Sydney Hotel in the evening.

ELECTRICAL ENGINEERING STUDENTS.

The results of the 1906 examinations of McGill University place A. M. Gray, of Edinburgh, Scotland, at the head of the fourth year students in Electrical Engineering, with the British Association medal; prize for summer thesis and honors in A. C. machinery, electric lighting and traction, hydraulics, thermodynamics and machine design.

The following passed for the degree of Bachelor of Science in Electrical Engineering: Alexander Miller Gray, Edinburgh, Scotland; Ian McLeish, London, England; John McNeill Forbes, Bonavista, Nfld; George Eric Brennan, Ottawa, Ont.; Clarence Victor Christie, Halifax, N.S.; James Harvie, Westmount, Que.; Melville Louis Hibbart, Farnham, Que.; Royden Keith Durland, Yarmouth, N.S.; Pearl Whitfield, Durkee, Digby, N.S.; Reginald Mudge, Montreal, Que.; Frederick Herbert Barrington, Waterloo, Que.; James deLancy Purdy, Springhill, N.S.; Andrew Douglas Gurd, Montreal, Que.; Daniel H. Ross, London, Ont.; Herbert Percival Thomas, Victoria, Australia.

The successful third year students in Electrical Engineering were: George W. Shearer, Montreal, Que.; James B. Woodyatt, Brantford, Ont.; George R. Wright, Salisbury, N.B.; Lot. A. Kenyon, Rochelle, Que.; Frank F. Griffin, Winnipeg, Man.; William D. Little, Morden, Man.; William H. Hargrave, Medicine Hat, N.W.T.; S. Barton Brown, Ottawa, Ont.; James H. Trimingham, Hamilton, Bermuda; Frederick H. Williams, East Sherbrooke, Que.; Ludlow St. J. Haskell, Montreal, Que.; Nathan L. Engel, Montreal, Que.; Robert R. Macdonald, Hamilton, Ont.

WESTERN CANADA

THE JONES & MOORE WINNIPEG FAILURE.

The recent failure of the Jones & Moore Electric Company, Limited, of Manitoba, has been much discussed in electrical circles, as they had been in business but a short time and it was therefore unexpected. The firm of Jones & Moore, of Toronto, absorbed or took over the Hicks Electric Company, of Winnipeg, and were incorporated in the above firm name, placing Mr. George J. Hicks, formerly manager of the Hicks Electric Company, in charge. Mr. Hicks left the company's employ, however, prior to the assignment.

Inside of ten months from the commencement of business the company was in the hands of the bailiff, with an apparent large deficit. The firm of Newton & Davidson were appointed assignees, and a meeting of the creditors was called for July 23rd, but for some reason was postponed until July 30th, when a large number of creditors were present.

A large list of creditors was submitted, the total liabilities being $30,267.14. The creditors thought it would be possible to realize 100 cents on the dollar, but it became known that a large amount of stock subscribed for had not been paid up, of which F. B. Moore, of Toronto, apparently owed $16,750, and J. W. Jones, of Toronto, $16,750. Mr. Clarence W. Bradshaw, of the legal firm of Bradshaw, Richards & Affleck, represented Jones and Moore, of Toronto, and produced an agreement purporting to show that Jones and Moore were not liable. The creditors, on the other hand, insisted that they were.

The two situations stand as below, marked "A" showing a deficit, and "B" after the subscribed stock is paid up :—

IN THE MATTER OF THE JONES & MOORE ELECTRIC CO. OF MANITOBA, WINNIPEG, MAN.

STATEMENT OF MERCANTILE ASSETS AND LIABILITIES.

ASSETS.			
Stock in trade as per inventory......		$11,508.08	
Machinery, tools and repairs..........		788.15	
Fixtures and office furniture..........		1,262.10	
Book accounts:			
Good................	$4,726.64		
Doubtful, 471.51, say	235.75		
Bad..... 540.72.....		4,962.39	
Cash on hand......................		582.95	
Amount earned on uncompleted contracts		317.53	$19,421.20
LIABILITIES.			
General Creditors....................		$29,345.40	
Wages due at date of assignment....		646.07	
Rent to August 1st..................		125.00	
Wages paid for services since assignm't		150.67	$30,267.14
Apparent deficit..............			10,345.94

GENERAL STATEMENT OF ASSETS AND LIABILITIES.

ASSETS.			
Mercantile assets as per statement....		$19,421.20	
Capital stock, authorized..	$75,000.00		
" subscribed..	50,100.00		
Still due on amount subscribed.......		40,165.00	$59,586.20
LIABILITIES.			
Mercantile liabilities as per statement		$30,267.14	
Capital stock account paid up........		9,935.00	$40,202.14
Apparent surplus...........			19,384.06

NEWTON & DAVIDSON,
Assignees and Accountants.

Winnipeg, July 27th, 1906.

As the result of the meeting, two inspectors were appointed, Messrs. Stuart and McHaffie, the former being president of the James Stuart Electrical Company and the latter manager of the Bank of British North America. Mr. Bradshaw wanted a representative of Jones and Moore as one of the inspectors, but this was voted down.

The meeting was adjourned subject to the call of the assignee.

PROPOSED WESTERN POWER DEVELOPMENT.

The Cranbrook Electric Light Company, of Cranbrook, B.C., have under consideration a proposition to develop 2,000 horse power on the St. Marys River, at a point about eight miles above the city. At the present time the company's engine is supplied by steam from the boiler house of the East Kootenay Lumber Company, but with the growth of the city increasing demands are making it imperative that a different source of power be secured.

City Engineer McCulloch, of Nelson, and Mr. Hagerman, C.E., of Cranbrook, have submitted reports of the St. Marys river site for a power house, and the matter is about to be brought before the directors of the company.

This company also owns and operates the telephone system in Cranbrook and vicinity. They have recently purchased and received another 150 line switchboard from the Kellogg Company of Chicago, which will be set up at once, giving them a 300 line system. They are also constructing nearly 100 miles of long distance telephone connection, the new lines extending east from Wardner to Elko, thence south to Elkmouth, taking in Jaffray, Baynes Lake, Baker, etc., en route. Westward the new trunk lines extend from Moyie to Yahk, taking in Tochty and Ryan en route.

Mr. H. D. Curtis, who was formerly manager of the company, resigned recently to go to Slocan City. His place in the office has been filled by Mr. E. W. Long, formerly of the Chatham Gas & Electric Light Company, of Chatham, Ont., who is now business manager, while Mr. McQuain, who has been with the company for some years, fills the position of superintendent of works.

MINNEDOSA ELECTRIC PLANT.

Among the many small electric lighting plants to be found in Manitoba none perhaps are in a more flourishing condition than that of Minnedosa. This plant, operated by the Minnedosa Electric Light Company, has been running for nearly two and a half years. The present owner is Mr. D. G. Craig, who one year ago took it over from the Ernest S. Harrison Company, of Winnipeg, who formerly owned it. At the time Mr. Craig bought it the plant consisted of a belt driven 22½ k.w. direct-current 320-volt dynamo of Westinghouse design, driven by a Robb-Armstrong engine. Since then considerable changes and improvements

have been made to the equipment. The old boiler was taken out last fall and a new one of 125 horsepower installed. This new boiler was made specially for this plant by the Goldie & McCulloch Company, and is built extra heavy, having a capacity of 125 lbs. pressure to the inch. At the same time another dynamo, also of Westinghouse design, was installed. The new dynamo is 50 k.w. direct current, direct connected to a Goldie & McCulloch "Ideal" engine. Both machines are in use during the winter, and it is the intention of the owner to replace the smaller generator by another one of capacity equal to the larger machine, in order to meet the increasing demand.

Electric lighting is taking well in Minnedosa. Being one of the older towns of the province, a large number of buildings had private gas plants. Since the advent of electricity, all but one of these plants have been replaced by electricity. Since the concern came into Mr. Craig's hands over 800 new lights have been installed in the town and he has recently secured the contract for lighting the C.P.R. station, roundhouse and shops. He expects to have well over 2,000 lights in use this coming winter. All the larger buildings now being erected are being wired and most of the stores and many of the houses already built are also adopting electric lights. Mr. Chas. W. Williams, formerly with the E. S. Harrison Company at Winnipeg, is in charge of the plant.

WINNIPEG'S POWER DEVELOPMENT.

The proposed municipal plant for electrical power is gradually being pushed forward in Winnipeg. Mr. Cecil B. Smith, of Toronto, met the Council at a special meeting and submitted the following :—

Proposal for engineering, superintendence and inspection of power plant on the Winnipeg river and transmission and transformation in connection therewith.

The undersigned submits the following proposal on behalf of himself and such associates as it may appear advisable to form into an engineering company.

A—To take complete charge of work.

B—To do all engineering, inspection and, if done by day labor, to supply a general superintendent of construction.

C—To engage and use the best civil, mechanical and electrical engineers as assistants in carrying on the work.

D—To include employment of such engineers at manufacturing plants to inspect the construction of machinery.

E—To include continuous consultation with highest experts on hydraulic and electrical machinery.

F—To give services of a full designing and constructing engineering staff, including expenses of any kind in connection therewith, such as office rents, living at power plant, travelling expenses, etc.

G—To push the work as rapidly as possible, consistent with economy, and hand over the plant complete ready to deliver electrical energy at low tension bus bars of Winnipeg sub-station.

H—The corporation to provide necessary right-of-way and all legal and purchasing right-of-way expenses.

K—The corporation to pay the salary of book-keepers, and, if by day labor, time-keepers and foremen.

L—The corporation to pay each month for above engineering services 5 per cent. of the expenditure during the preceding month, such expenditure not to include legal or engineering items.

M—The total payments to be limited to 5 per cent. of $2,500,000, or in other words not to exceed $125,000 for present contemplated development.

N—Such expenditure to absorb all engineering fees paid up to the date at which an agreement is entered into.

Respectfully submitted,
CECIL B. SMITH.

Mr. Smith is reported to have made another proposal on a straight salary basis, offering to devote one-half his time to superintending the construction of the plant for $5,000 a year. He assures the City Council that the plant can be built within the estimates already submitted.

SELKIRK ELECTRIC PLANT.

Messrs. Flavelle, of Lindsay, Ont., James Stuart, of Winnipeg, and others have bought out the plant of the Selkirk (Manitoba) Electric Light & Power Company and a new company has been formed. It is said the price paid was $40,000, and $10,000 additional is to be spent in the remodelling of the entire plant. Several Winnipeg capitalists are interested in the new company, and Mr. Jas. Stuart, of the Stuart Electric Company, Winnipeg, has been elected secretary.

IMPROVEMENTS AT BOISSEVAIN.

Large electrical, waterworks, and sewerage construction works are spoken of for Boissevain, Man. Mr. Cecil Goddard, C. E., has been appointed consulting engineer for the town in connection with the proposed system, and is now in charge. He will make a survey to bring water from Lake Max into the town by gravity for a distance of thirteen miles.

ADAM BECK IN THE WEST.

Hon. Adam Beck, of the Power Commission, gave an interesting address before the Canadian Club of Winnipeg. on "The Electric Power Problem", a subject of great interest to Winnipeg and the West. A complimentary luncheon was tendered Mr. Beck by the Club, which many of the leading Winnipeggers attended.

CIVIL ENGINEERS' EXCURSION.

The Canadian Society of Civil Engineers are rapidly completing arrangements for the proposed trip to the Pacific Coast. The party will leave Montreal by the Canadian Pacific Railway on Saturday, September 8th, at 9 a.m. Going west it is proposed to visit Winnipeg, Calgary, Banff, Field, and Glacier and to reach Vancouver about September 16th. Returning, the party will leave Vancouver on September 19th, go down the Arrow Lakes and visit points of interest in the Boundary and the Crow's Nest districts. On their return journey a stop will be made at Fort William to inspect the terminal facilities of the C.P.R., and Montreal will be reached about September 28th.

A committee of the Montreal City Council have been conferring with the Montreal Light, Heat & Power Company on the subject of rates for lighting, and it is understood that an agreement has been reached which provides for a reduction in consideration of an extension of the present franchise for thirty years for both electric light and gas. Both contracts would begin in May, 1910, and continue for thirty years regardless of the unexpired time of the existing contracts. It is understood that no alteration has been agreed on in the price of street lighting, which will remain at the same price as under the existing contract.

MONTREAL

Branch Office of THE CANADIAN ELECTRICAL NEWS,
Room B33 Board of Trade Building
August 8th, 1906.

The observation car, which used to be run by an American firm and which met with strenuous opposition from the city hackmen, is now doing good business in peace. The Street Railway control it themselves, which is as it should be; and it is not only well patronized by tourists but by our own public. The car is a special one and a very handsome piece of rolling stock; its first appearance was made on the night when the convention of the Canadian Electrical Association met last in Montreal, and was used to take a number of the delegates out to the smoking concert held at the Back River.

Great interest is being taken by the public at large in an electric switch installed by the Street Railway lately at the busy corner of St. James and McGill streets. The tongue is operated by a trolley contact located a couple of cars length back from the corner. The public are somewhat mystified to see the tongue move without anyone touching it.

The Westmount municipal plant is doing well and the incinerator addition is doing good work. The dayload is carried entirely by the burning of garbage, coal being used in the evenings and Sundays when no garbage is brought in. It is pretty hard for water power to beat this combination, but it remains to be seen whether, when the plant is handed over by the engineers, it will be run on the same business basis by the Town, or whether the patronage system will creep in. The streets will probably be lit this winter, and it is said the new Magnetite arc lamp will be installed and operated from the alternating current circuit through mercury arc rectifiers.

An amusing article in the daily press recently informed the public that Dr. Lee De Forest, of wireless telegraph fame, had received a shock in Ottawa of 200,000 volts. It would be interesting to know just what he did get, and whether it was a condenser discharge or not. If the amperes are kept low enough a few thousand volts more or less will not be apt to do much damage to anyone.

The contract for the wiring of the entire buildings of the new Macdonald Agricultural College at Ste. Annes de Bellevue has been awarded to Mr. P. Lahee, of this city. The contract is a large one, and Mr. Lahee is to be congratulated.

The C. P. R. are running a motor car from Montreal to the head of the island at Ste. Annes. The car is operated by liquid fuel, the whole making one compact car with the small engine in the front portion of same. This is a step in the right direction to handle suburban traffic, but why not electrify it at once? It is bound to come in time and there is no particnlar object in putting off the day.

The influx of automobile tourists has shown a woeful need of something better than the usual two cell accumulator for creating the spark. With a little more perfecting the dry battery ought surely to put the accumulator on the shelf for this purpose, and dry batteries have made magnificent strides in the last year or two, whereas the accumulator has done nothing for itself in the last ten years.

The Montreal Street Railway are showing practical philanthropy in their efforts to give some of the young children, who have no means of getting away to the country, a breath of fresh air. Every day in the week sees them take out car after car, all of which are "special" and reserved for the children exclusively, gratis. They give them a ride around the Mountain, etc.

The Bell Telephone Company are to be congratulated on the excellent long distance service they are at present providing for their patrons in Montreal. The same congratulations, however, cannot be extended for local work, where "cutting off" is the order of the day. This will probably be improved, however, when the new Uptown Exchange on Mountain street (now rapidly nearing completion) is put into service. Talk is heard of various opposition exchanges in other cities, but there appears to be no scheme of this sort in hand in Montreal—for which let the public be duly thankful. Anyone who has had experience with two telephones in the days of the old Federal Company will agree that what is wanted is one company only, with good service and fair rates.

It would seem from remarks made by the Toronto inspector, Mr. Strickland, lately that some contractors think they should get certificates "free". We, down here, would not mind paying a fair charge, but would first like to have an official inspector appointed by the Underwriters. Surely such fees would pretty nigh reimburse the Underwriters for the salary paid such an individual, especially as inspection would then be conpulsory. If the Underwriters do not do something soon the city will, and there are ten chances to one that someone with aldermanic pull will get the job to the regret of the contractors generally and of no real benefit to the Underwriters, who will then have none but themselves to blame.

It is with pleasure that Montrealers recognize the name of Mr. R. S. Kelsch in an important Executive position of the Canadian Electrical Association. Mr. Kelsch has had the experience and is a man of the stamp required, and the more of his calibre that can be secured for such positions the more will the prestige and value of the Canadian Electrical Association be enhanced.

The intense heat during June and July has made great inroads on the stock of fans. During the last week or so, there has not been a desk alternating fan to be had for love or money from any of the larger dealers. Montreal is a tantalizing place to handle fans, for it has happened that stocks of fans were laid in and the summer turned out entirely cool and wet, the whole stock then having to be carried over through the winter, when of course there is absolutely no sale. Such a stock is expensive and takes up room. The question, therefore, is about as intricate in a small way for the manufacturer of these articles as the handling of the daily six o'clock rush is for Street Railway Companies.

The Electrical Fraternity in Montreal will be sorry to learn that we are losing Mr. Logan, who for some time has acted as manager for Mr. John Forman, of this city. Mr. Logan leaves shortly to take up a position with the sales department of the General Electric Company in his native city, Toronto. Mr. Logan's personality is such that he was highly esteemed by all those coming in contract with him in a business way, and his loss will be felt amongst the boys.

ELECTRICAL TRADES EXHIBITION.

The Electrical Trades Exhibition, which purported to be held in September next, has been postponed until a date to be named later. This is the outcome of two conditions, viz., that the local manufacturers could not give the necessary attention to it or get ready the exhibits which they would desire in the short space of time allotted, and secondly, it looked as if the exhibition would grow to such size that larger premises than those which were at first secured would be necessary. As a large attendance both of exhibitors and visitors had already been promised, they will be pleased to know that the delay thus enforced will only mean that they will have more to see than was ever expected when the exhibition does take place, as it is hoped to make it as large and successful as the former one held in the Victoria Rink, Montreal, just fifteen years ago. At that time the Edison Company required to run a generator and engine in a tent in the McGill college grounds, the mains being carried on the Bell Telephone poles down to the Victoria Rink, where they operated a 500 volt direct current motor, which in its turn was coupled up to a 110 volt Edison bi-polar generator. One of the strong opponents to the Edison Company was the old Thomson Houston Company, of Lynn, Mass., who exhibited at that time a composite wound alternator with transformers, etc., of 133 cycles, being the latest development of the art at that date. Now these great rivals are merged in one, viz., the General Electric Company, and both the composite wound alternator and 133 cycles are rapidly becoming things of the far distant past.

About the only local dealer exhibiting supplies at that date in Montreal was T. W. Ness, now general manager of the Holtzer Cabot Electric Company in Brooklyn, Mass. There were also good exhibits at that date from our American friends, such as the Phoenix Glass Company, the Fort Wayne Electric Company, and many others.

The stimulus given by that exhibition to the trade locally and throughout Canada was tremendous, and if the proposed exhibition does as well it will be a matter of regret for those of the fraternity that do not take it in.

The old Royal Electric Company probably did not possess a motor circuit; the Lachine Rapids Company had not even been dreamt of; now the two are amalgamated together and some of the largest motors in the country are operated on continuous service in this city. The old exhibition, as many will remember, was opened by Sir Donald Smith (now Lord Strathcona), who made a capital speech from the directors' gallery of the Victoria Rink, and pushing the button declared the exhibition "open"; the effect of the blaze of incandescent lights and arcs was one which will be remembered by many, especially as the rink was then lighted by a miserable arrangement of gas jets from circles hung in the centre.

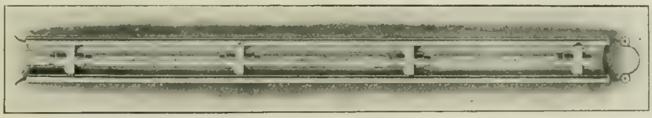
Possibly the first fan motor seen in Montreal was at that Exhibition; it was for 110 volt direct current, no alternating fan motor being then on the market, now it is hard to find an office without either the one or the other, and locally the bulk are alternating.

A NEW METHOD OF LIGHTING.

What appears to be an important advance upon the present method of electric lighting by glow-lamps has been effected by the recent introduction of a novel and simple system known as "Linolite."

As its name appropriately suggests, the characteristic feature of the system is the substitution of a "line of light" for the coiled filament of the ordinary glow-lamp. The principle remains the same, the difference being one of form. That is, the light is generated, in the ordinary way, by an incandescent carbon filament. But whereas in the ordinary lamp this filament is coiled, or "bunched," the Linolite lamp is tubular. The filaments are of the same length as those used in the ordinary incandescent lamp, the important difference being that they are either straight or have merely a small expansion-loop at the centre. By this means all parts of the filament occupy the same relative position to the semi-tubular reflector in which the line of lamps is inserted. As the filament is straight instead of coiled, from twice to four times the usual length of reflector is placed behind a given length of filament than is possible with an ordinary glow-lamp.

Naturally, the result of the coiled arrangements with which we are all familiar is the production of intense illumination from a limited area ; so that whereas the light from a glow-lamp is a highly concentrated one, it is in the Linolite system evenly distributed, and the whole of the light generated by the filament is available for any specific purpose. Photometric measurements show that this new design vastly increases the amount of light thrown forward through a very wide angle. In the actual amount of light generated there is, of course, no increase. The important point is that the arrangement of the filament enables the reflector to act with maximum power over a greatly increased proportion of the incandescent filament, thereby yielding a much greater percentage of light from a lamp of given candle-power.



THE "LINOLITE" SYSTEM : SHOWING SUCCESSION OF LAMPS.

The "end-on" candle-power of an ordinary coiled filament is usually about 60 per cent. of its maximum candle-power. Linolite claims to have no "end-on" candle-power, and to have the filament and reflector so arranged as to give the maximum candle-power in the direction in which it is required. The reflector is simply a metal channel, semi-circular in cross-section, having an over-all width of 2¼ inches, and a depth of one inch. Both its edges are rolled round in the form of a small bead, each of which carries one of the electric wires. This arrangement serves not only to keep the wires well apart, but to protect them from injury. The lamps (which are of 8 and 12 candle power) are made for all the usual voltages. For any particular voltage the current used is the same as that for an ordinary glow-lamp of the same power and voltage.

For indoor lighting a highly polished aluminum reflector is usually employed, while for outdoor work the reflector is of white enamelled zinc. A useful pattern for the illumination of sign-boards is one containing four lines of lamps side by side in a single reflector. In this case, each line may differ in color, and the current can be automatically switched from one line of lamps to another in repeated succession.

The standard Linolite lamp is of 12 candle-power, and takes 45 watts, but larger sections, fitted with lamps up to 32 candle-power, are also being made. Taking the cost of electrical energy at 6d. per Board of Trade unit of 1,000 watt hours, the cost of running Linolite works out at 1d. per yd. per hour. It is claimed that, for the same consumption of energy, from 50 to 100 per cent. more available light may be expected from Linolite than is obtainable from ordinary glow-lamps.

To secure an efficient illumination of 150 square feet of floor-space by direct lighting, three 16 candle-power ordinary glow-lamps would be required, whereas the same space could be lighted by 1 foot 8 inches of Linolite—in other words, half the current would be saved. The preferable arrangement, however, is, not to reduce the quantity of current used, but to install such lengths of Linolite as will take nearly as much current as is allowed by the usual practice when lighting with ordinary glow-lamps, and then to direct the light from the Linolite on to a white ceiling. By this method a perfect distribution of the light is obtained, which we have found is very pleasing in effect.

An important feature of this novel system is that it lends itself to the most varied requirements. It would, in fact, appear adaptable to almost any description of building, public or private, for it can be placed in any position, and turned upwards, downwards, inwards, or outwards.

The strongest points are its inherent quality of adaptability to almost every conceivable requirement, its novelty, economy, and striking simplicity; and there should certainly be a brilliant future for the invention. The Midland Electric Company, of Montreal, are sole agents for Canada.

PRICES OF ELECTRICAL SUPPLIES.

A letter written to a western contemporary in the United States is so pertinent to Canadian business that some of it is well worth copying. The writer in explaining low prices states :—

"As it is now, the net lists of the jobbers are scattered broadcast, and it is almost impossible to find a concern, using any amount of electrical supplies, but has from one to a dozen jobber's catalogues with net wholesale prices. They may be had by any one for the asking.

"In the hardware business, it is customary for wholesalers to run a retail department, but they retail at retail prices, which leaves a margin of profit between their wholesale price and their retail price of from 20 per cent. on the ordinary staple articles to 100 per cent. on some other articles, the ordinary per cent. of profit reserved for the retailer being from 33 1-3 to 50 per cent.

"Retail dealers in electrical supplies are not less alive to their interests than dealers in other lines, but the jobber has placed a barrier in their way which leaves them no choice.

"There should be nothing but the kindliest feeling between the jobber and the retailer, and we believe this could be brought about by the jobbers adopting a retail price list, which would be their minimum price to consumers, and which would be, without doubt, adopted by central stations and contractors as their minimum retail price. In certain quantities (say 25 sockets), a 10 per cent. discount might be allowed. From these retail prices, the retailer or contractor should be allowed a discount ranging from 33 1-3 to 50 per cent.

"We believe this would do away with much of the price cutting, the strenuous effort on the part of the contractor to buy at a price where he could compete with the jobber's retail price, and would afford the contractor or retailer a fair margin of profit, and the jobber with a retail department would make a larger per cent. of profit on his retail business.

"The contractor is willing to pay a fair price for his material, for the apparatus and appliances he installs, as long as he knows he is protected by the manufacturer and jobber, and can secure a fair margin of profit over and above the cost to him.

"This is a matter of much importance to all concerned in the electrical business : to the manufacturer, if he expects to secure a fair price for his product : to the jobber, if he cares for the business and good-will of the contractor, and to the contractor, if he expects to carry on a business which will yield him a profit in comparison with the knowledge and experience it requires to carry on his business."

The Water and Light Commissioners of Barrie, Ont., have accepted the tender of the Goldie & McCulloch Company, of Galt, for a 450 h.p. cross-compound condensing engine, at the price of $5,891. Allis-Chalmers-Bulloch, of Montreal, will furnish a 300 k.w. generator for $5,862.

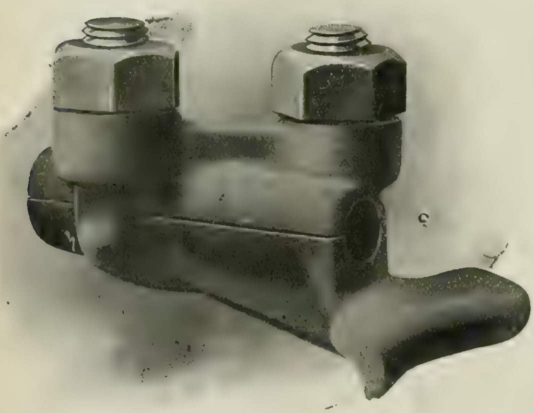
CLARK INSULATOR CLAMPS.

The mechanical construction of a transmission line has in the last few years been given much attention by transmission engineers. In fact, this side of the problem has become of the first consideration, and every scheme has been tried the cost of which would not be prohibitive. Expensive steel towers are used, high tensile strength conductors, steel pins and large and strong insulators. This is all very strong and rigid construction, but one link of the old chain still remained by which we must calculate the strength of the whole. This old link is the joint between conductor and insulator, which can only stand about one-tenth the strain for which the rest of the construction is designed. Some of the joints will either break or allow the conductor to slip through them under the pressure of the wind, and this unbalancing of the line is very apt to result in either the conductor being completely pulled away from some of the insulators, or the breaking of the pins or insulators. There are many slight curves in transmission lines where it is not practicable to employ strain insulators. Due to the tight stringing of the conductor, the middle supports at these slight curves are under considerable strain, the conductor continually pulling towards its natural path; a straight line between the end supports. Let us suppose that a sudden gust of wind struck the line unevenly, affecting to a much greater extent one of the spans some distance away from the curve. With a joint as non-mechanical and consequently unreliable and weak as the tie wire, it would be very probable that the conductor would be pulled over the insulator into the span most affected, and the adjacent spans would be considerably tightened. If the spans of the curve should be tightened only slightly, the side strain at the middle support would be greatly increased, and in this case in all probability the tie would break and allow the conductor to fall on the cross arm and thus cripple the whole line.

The construction over hills must also be taken into consideration. Here the conductor tends to sag at the bottom of the hill, and tighten up on the spans at the top. The strain is accordingly unequally divided, and the line under adverse weather conditions, is liable to be disabled.

These are the causes of some of the many mechanical failures of the transmission line which are apt to result in great inconvenience and expense.

The remedy for these evils, most practical and inexpensive, is



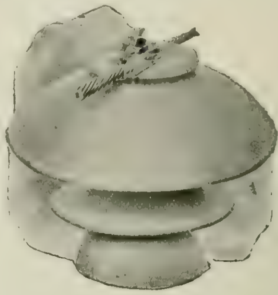
UNDERLOCKING INSULATOR CLAMP.
This clamp is designed to clamp firmly on the conductor on each side of the insulator.

to make each span in the line as much as possible an individual unit. This can be done by using a joint between the conductor and insulators which will be strong and reliable, such as is afforded by the Clark Insulator Clamps. With each span a unit the probable maximum strain in each span may be calculated, and after taking into consideration the counteracting strains on the supports of adjoining spans, the strength of each part in the construction may be calculated for the greatest efficiency and economy.

Under very abnormal conditions the joints between conductor and insulators should be allowed to break before the insulators are cracked or towers pulled over, and we would point out in this connection that the clamps can be made to break at about any desired strain.

The Clark Insulator Clamps are now in use on many important transmission lines, such as those of the Rio de Janeiro Tramway, Light & Power Co., the Mexican Light & Power Co., the North Georgia Electric Co., the National Railway Construction Co., and by the General Electric Co., in Brazil, etc.

The R. E. T. Pringle Company, Limited, whose new factory and head offices have been recently completed in Montreal, are



INTERLOCKING INSULATOR CLAMP,
Showing position of clamp in insulator.

prepared to quote prices and furnish these clamps to fit any insulator and conductor which may be used.

Any inquiries addressed to their sales offices, 16-18 Victoria square, Montreal, or to their branch offices in St. John, N.B., Toronto, Ont., and Winnipeg, Man., will be cheerfully answered.

TRADE NOTES.

The Centre Star Mining Company, of Rossland, B.C., have ordered a 650 h.p. Westinghouse motor of the C.C.L. type.

Messrs. Chas. Barber & Sons are installing two of their 60 inch Canadian turbines for the plant of the Galt Gas Light Company at Galt, Ont.

We understand that Messrs. J. A. Dawson & Company, railway, electrical and mill supplies, Montreal, have been appointed Canadian agents for the Couch & Seeley Company's telephones, and that they will be pleased to forward their catalogue No. 8 to interested parties. Dawson & Company are also Canadian agents for the Jacks n instantaneous wrench manufactured by the Union Tool Company.

The corporation of Fredericton, N.B., has awarded to Allis-Chalmers-Bullock, Limited, Montreal, the contract for the municipal pumping engine. It will consist of an "Allis" high duty, horizontal, double acting, crank and flywheel plunger pump, driven by a cross-compound "Reynolds"-Corliss engine. The pump will have a capacity of 1,500,000 gallons for ordinary service and of 4,000,000 for fire service. Both pump and engine will be built at the works of Allis-Chalmers-Bullock, Limited, in Montreal.

PUBLICATIONS.

"The Economical Lighting of Industrial Plants" is the title of a booklet which recently reached our desk, the purpose of which is to show the advantages possessed by the Cooper-Hewitt lamp.

A very useful book has been published by the Wire & Cable Company, of Montreal, the title of which is "Electrical Conductors." It contains numerous tables pertaining to copper, brass, aluminum an other wires, as well as a general wiring formulæ which should be und very useful. We have no doubt that the company would be willing to send one of these books to any interested party.

The nineteenth volume of the Transactions of the Engineering Society of the School of Practical Science, Toronto, reached our desk last month. The papers read before the Society were all instructive and interesting, and included the following: Electric Street Railways and Their Equipment," by L. W. Morden; "Notes on Pumping Conditions and Limitations," by W. S. Pardoe; "Construction of 18-Foot Steel Conduit of the Ontario Power Company at Niagara Falls," by T. H. Hogg, and "Concerning Chimneys," by P. Gillespie.

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STEAM-TURBO GENERATOR PLANT.

The Ottawa Electric Company have recently added to their steam power station a Westinghouse turbo-generator unit of 1500 k.w. capacity. This unit is to serve as an auxiliary to their four waterpower stations to take the peak of their lighting load in the early evening during the winter months when water is low.

The new installation consists of three 400 H. P. Babcock & Wilcox water tube boilers with forged steel headers, a 2250 B.H.P. Westinghouse-Parsons turbine direct connected on single bed plate with a Westinghouse rotary field, two-phase generator of 1500 K.W. capacity, and a barometric condenser with dry air pump.

In addition to the steam power house a building was erected to accommodate the new boiler plant. The old brick stack is utilized by the new boilers, while a new 60 inch steel stack 115 feet tall, erected beside the old stack, takes care of the old battery of boilers.

The steam pressure is 150 lbs. Superheaters are not used, but a steam separator is placed directly under the main valve of the turbine, which insures practically dry steam at the throttle.

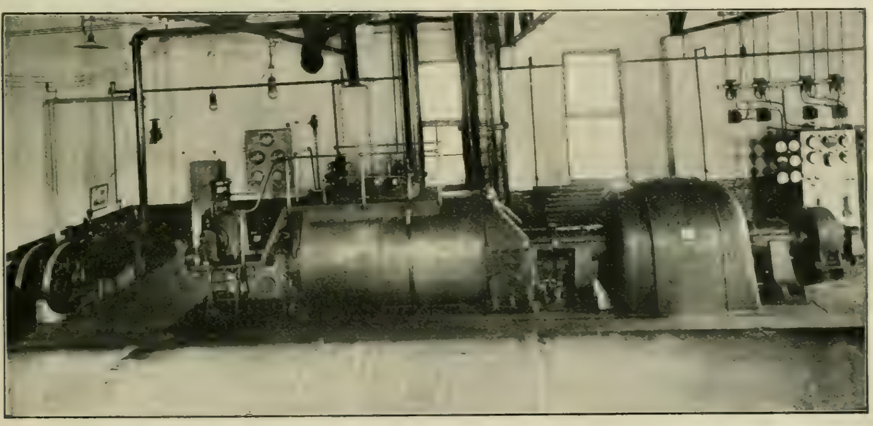
The turbine is of the Westinghouse standard type for this size and is provided with a secondary governor valve which is automatically opened to allow the passage of high pressure steam to the low pressure end of the turbine. By this means full load may be developed when running non-condensing, or a fifty per cent. overload when running condensing.

There is also an auxiliary governor operating an automatic cut-off valve which closes the steam supply in case the speed of the turbine reaches the safety limit.

The governor is adjusted to regulate within four per cent. of average speed at any load within the limits of the turbine.

The guaranteed steam consumption is 15.3 lbs. of steam per B.H.P. at full load.

The exhaust steam is condensed in a Worthington type barometric condenser made by the John McDougall Caledonian Iron Works Company of Montreal. This condenser has a 30 inch head, lifts its own water through a 14 inch supply pipe and discharges to hot well through a 14 inch tail pipe. No circulating pump is required. Vacuum is maintained by a dry air pump with positive and outlet valves and water jacketed air cylinder.



Westinghouse-Parsons Turbo-Generator Unit of the Ottawa Electric Company—1500 K. W.

PERSONAL.

Mr. Charles H. Mitchell, C.E., has recently returned from his eight months' tour in Europe, where amongst other matters he has been studying the water power and electric installations in Italy, Switzerland and Austria. For four years previously Mr. Mitchell, who is well known in Canadian engineering circles, was chief assistant engineer of the Ontario Power Company at Niagara Falls. Mr. Mitchell will resume his former consulting practice, making a specialty in hydro-electric work and railways, and while still retaining an office at Niagara Falls, Canada, will establish an office also in the Traders Bank Building, Toronto, after October 1st.

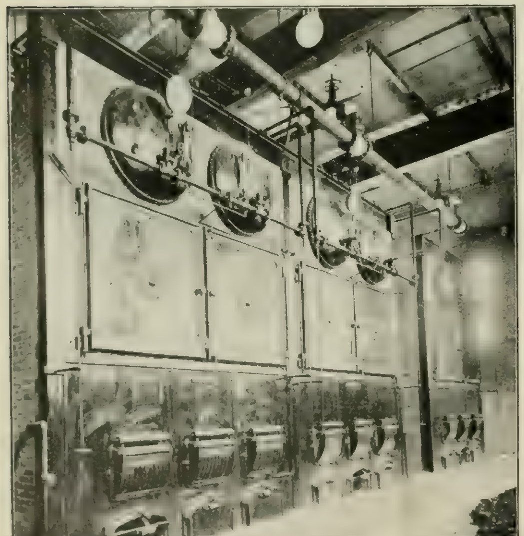
ELECTRICAL DEVELOPMENT ON THE COAST.

Work on the extension of electric lights to North Vancouver is being rapidly pushed forward by the British Columbia Electric Railway Company and it is expected that lighting service there will begin this month. In crossing Burrard Inlet at what is known locally as the "Second Narrows," two masts each 240 feet high are used, the span being some 950 feet. The company is putting in a 1,000 k. w. rotary at the Vancouver sub-station, and a new 1,500 k. w. generator at the Lake Buntzen power house, together with the necessary water wheel of Pelton manufacture, transformers, etc.

The British Columbia Electric Railway Company are discarding all the old D. C. arc lamps, and are installing Canadian General Electric enclosed A. C. arcs. They are also changing all power circuits in the city from two phase to three phase 2,000 volts. The company is extending its system of rural electric lighting to the town of Ladner on the Fraser River below New Westminster, and in anticipation of this many of the houses and business places at Ladner are being wired.

Ladner is 13½ miles from the sub-station on Lulu Island, from where the company is running three phase 20,000 volts stepped down to three phase 2,000 volts at Ladner. In crossing the Fraser River en route, four masts, each 240 feet high, are used, enabling the wires to be 150 feet above high tide, with 1,200 foot spans between.

The Canadian Westinghouse Company, through the



INTERIOR VIEW OF NEW BOILER ROOM, OTTAWA ELECTRIC COMPANY.

agency of their Vancouver office, has closed a contract with the Granby Consolidated Mining, Smelting and Power Company, of Grand Forks, B.C., for the supply of three electric locomotives. These locomotives are of a special type, being 30 horse power, for operation on a 20 inch gauge track. They are also supplying the same company with four 150 horse power type "C" induction motors.

The City of Grand Forks, B.C., has given the Canadian Westinghouse Company the contract for the supply of all the transformers required for the ensuing year.

The Greenwood Electric Light Company have purchased a five panel switchboard and step down transformer for their new hydraulic plant, which is being constructed at Boundary Falls.

The Kettle River Lumber Company, of Grand Forks,

AUXILIARY POWER HOUSE OF OTTAWA ELECTRIC COMPANY.

B.C., are replacing their steam power plant with Canadian Westinghouse motors, having concluded arrangements with the city of Grand Forks for the supply of power.

The City of Revelstoke, B. C., recently installed a Canadian General Electric 120 k. w. revolving armature, alternating current, 2300 volt, 125 cycle generator. This is in addition to their other generator of a similar size and type. They also installed additional switchboard and exciter and added a sub-base to the old switchboard. They have further spent about $8,000 building protection work at the dam above the power house. The City Council is about to take up the matter of installing a steam auxiliary plant for use during the winter months when the river is sometimes choked with floating ice. Mr. R. Gordon, the manager of this plant, has recently been on a month's vacation, during which he attended the Canadian Electrical Association convention at Niagara Falls. Mr. Geo. Lembke was in charge of the plant during Mr. Gordon's absence.

The McGraw Publishing Company, of New York, have issued a work entitled "A Graphical Treatment of the Induction Motor," by Alexander Heyland, it being a translation from the second edition by G. H. Rowe and R. E. Hellmund. The object of the method described in the book is the experimental determination of the characteristic properties of induction motors. It consists essentially in the practical application of the circle diagram and is based on two simple and quickly performed experimental tests on the finished motor. The price of the book is $1.00.

The Century Telephone Construction Company, incorporat under the laws of the State of New York, has been granted a license to do business in Ontario, Mr. A. F. Wilson, barrister, Toronto, being named as attorney. They will manufacture and sell telephones, switchboards, etc., and install telephone systems

The Convention in England of Foreign Electrical Engineers

By Charles H. Mitchell, C. E.

Probably no more representative international gathering of electrical men has yet occurred than that in England in July last. Within the past few years the members of the Institution of Electrical Engineers had visited Italy, Germany and America, and this year they reciprocated by acting hosts to about one hundred and fifty electrical engineers from America, France Germany, Italy, Switzerland, and other countries. As Englishmen ever do when they entertain, it was a royal reception that was tendered to the "Foreign Engineers"; it was none the less a vigorous round of sight seeing, a hard working travelling "summer school for all classes," and a hearty international exchange of ideas in electrical matters.

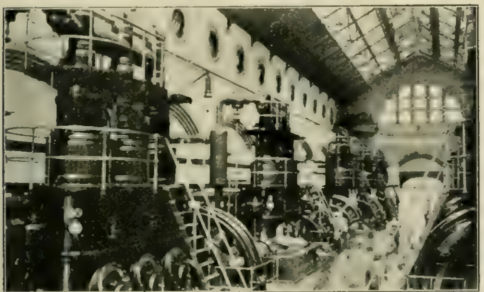


Fig. 1.—Interior of Liverpool City Generating Station.

At the welcome banquet at the Hotel Cecil in London on June 25th, the first gathering of the convention, there were present about 500 ladies and gentlemen, including those delegate members to the International Commission on electrical standards, which represented all the principal countries of the world. Of the latter Professors R. B. Owens and L. A. Herdt, of McGill University, Montreal, were from the Canadian Electrical Association. As a banquet the most noticeable feature was the babel of tongues, each guest seemingly endeavoring to talk any language but his own to his neighbors, in a very high key. For instance, within talking range of the writer were two German, two Italian, two French, one Swiss, one Japanese and four English representatives of the profession: the result is obvious. A pleasant incident of this banquet was the presentation to the Institution by the Italian section of a bronze bust of Volta, "the father of electricity," of whom his compatriots are very proud.

Several days were spent about London, one of which being in technical sight seeing, for which the large party divided into groups. Perhaps the most interesting of these was the visit to the Greenwich generating station of the London County Council which had been in operation only two months. This steam station will ultimately be 50,000 H. P. capacity and at the present time has 20,000 H. P. in four units of vertical reciprocating engine type. This plant, while most modern in all details, has been criticized in some quarters for its conservatism in adopting reciprocating engines: it has also become notorious on account of the controversy as to its location, the four tall chimneys being on the meridian and about a quarter mile north of the Greenwich observatory. The coal handling and boiler installation of this plant is ideal, providing a very quick and almost automatic feed from the ocean steamer to the grates. This station is being used for traction and mixed motor load; the capital cost is said to be about $130.00 per k.w. and the estimated working cost 0.5 cent per k.w. hour, with coal at $2.20 per ton.

The ten days' circular tour through England and Scotland formed, of course, the chief attraction in the visit and proved that for complete and comfortable travelling accommodation England is quite abreast of America. The party consisted of about 200 from the respective national societies, comprising 40 English, 17 French, 40 Italian, 70 German, 15 Swiss, and only 15 American, of whom the writer was the only Canadian. The London and North-Western Railway placed a train of 9 dining cars and 2 luggage vans at the dis-

Fig. 2. Foreign Engineers on Firth of Clyde.

posal of the party, in which all meals were served while travelling; stops over night were made at hotels in the cities along the route. In a general way the following itineary was carried out, one day being devoted to seeing engineering works in each city named: Birmingham, Manchester, Liverpool, Glasgow, Edinburgh, Newcastle-on-Tyne, and Leeds. In addition to these there were three holiday or rest days, Sunday being spent on the English Lakes, one day down the Firth of Clyde and one day at Harrogate, the celebrated inland summer resort near Leeds.

The Institution of Electrical Engineers had the most perfect arrangements on this tour for the comfort of their guests, quite surpassing, so it was said, the similar arrangements of their tour in America. Notable in this respect were the generous receptions held by the municipal and manufacturing corporations in the several cities, which partook of semi-social fuuctions and sumptuous dinners and luncheons. Perhaps the most striking of these was the gift of the Babcock & Wilcox Company at Glasgow, who provided a special train and after showing the guests through their works at Renfrew, took the whole party, about 400 in number, on a seven hour trip down the Firth of Clyde and through the Kyles of Bute, in a magnificently appointed turbine steamer, serving both luncheon and tea on board. Not the least interesting of these functions

Fig. 3.—Coaching Party at Harrogate.

(On this coach were Mr John Gavey, C B., President of the Institution; Mr. W. M Mordey, Vice-President; Dr. Wheeler, President of American Institute; Messrs. Lieb and Mailloux, of New York, and Sig. Semenza, of Milan.)

were the conversaziones in the Universities at Manchester, Glasgow and Leeds. Many very interesting experiments were made in the different laboratories, among which may be noted those with new lamps, the phonographic recording telephone, and especially those in the textile and leather laboratories of Leeds University. At Glasgow University the Italian section presented Lord Kelvin, who is now in his eighty-fourth year, with two portfolios containing about 1,500 photo reproductions of the sketches and notes of Leonardo da Vinci recently discovered in Milan; these are 400 years old and present many interesting studies of those days, especially in hydraulic engineering, which was Leonardo's specialty rather than the painting for which he has been so famous.

At Birmingham the new city steam turbine station and the Birmingham small arms works were visited. In Manchester the city station at Stuart street and the British Westinghouse works at Trafford Park were inspected, followed by a trip on the Manchester ship canal to see several large locks. In Liverpool a most interesting railway system, that of the Lancashire & Yorkshire Company, was examined, a feature of which were the excellent coaches of the American type having extreme width and very commodious end vestibules. An illustration of the interior of the generating station of the City of Liverpool light and power system is here given and may be noted as one of the steam reciprocating engine stations of England which are generating current at a very low cost. The generating stations and distribution of power in Glasgow are, as is well known, typical examples of municipally owned and operated works which according to the statements made by the officers provide maximum efficiency with minimum cost; for instance, the price of a street car ride of say one half mile is only one cent, while one can go anywhere in the city for two cents.

Visits were made also to the ship yard down the Clyde, where among other vessels seen in building were the "Dreadnaught" and the Cunarder "Lusitania," the latter to be propelled by four turbine engines of 75,000 h. p. total. Newcastle-on-Tyne furnished examples of power generated by steam under the most favorable conditions at the pit's mouth. Here also is situated one of the manufactories of Parsons turbines, which was inspected by the members with the greatest interest, and on the river was seen the historic "Turbinia". A trip down the Tyne from Newcastle to the sea, about 10 miles, presented an object lesson of England's greatness in shipbuilding and manufacturing, after seeing which one cannot believe the latter day rumors of England's decline in this respect.

The closing day of the tour, spent in a coaching trip between Harrogate, Ripon and Fountains Abbey, offered a glimpse of rural England such as visiting foreigners seldom see, and the charms of the monastic ruins of the latter, where the party had luncheon in the cloisters, carried one back to the dim days when man-power and horse-power were the only power factors in those green valleys.

TRADE NOTES.

In order to get rid of the sewage east of Woodbine avenue, the City Council of Toronto has purchased from Allis-Chalmers-Bullock, Limited, of Montreal, a set of two 4-in. vertical submerged centrifugal pumps to be driven by two of their induction motors for station No. 1, at the south end of Kenilworth avenue, and another similar set to be driven by two of their induction motors for station No. 2, on the lake front. Each pump will be capable of lifting 550,000 gallons in 24 hours.

What is claimed to be the largest generator ever made in this country has just been made ready for shipment to British Columbia from the works of the Canadian Westinghouse Company, of Hamilton. The purchaser is the British Columbia Electric Railway Company, of Vancouver. The generator is 2,000 horse power, 3 phase, 7,200 alternations, 400 revolutions per minute, engine type for direct connection with the water wheel. The order also includes one rotary converter of 1,350 horse power, 550 volts, 3 phase, 7,200 alternations, 200 revolutions per minute, and eight air-blast transformers each of 733 horse power, 2,200 volts to 24,200 volts, 7,200 alternations. The necessary switchboards and regulating and controlling devices were also manufactured in this plant. The new machinery is required by the Vancouver Company to provide added power to meet the ever increasing demand of Vancouver and vicinity. It is the fourth generator of the size ordered by the Vancouver Company, but the other three were supplied by the Westinghouse Company from its Pittsburg works previous to the building of the Hamilton works. The one now ready for shipment is by long odds the largest ever manufactured in Canada.

Westmount Refuse Destructor and Lighting Plant

The town of Westmount, just outside of Montreal, has been furnishing lately some valuable data on the results obtained from its combined refuse destuctor and electric lighting plant. The problem of burning garbage to advantage in Canada has long been regarded as impossible, owing to the wet nature of the material.

The Westmount destuctor has proved in actual practise that it is possible not only to burn the garbage, winter and summer, but to use the heat generated by such burning for the partial running of electric light generating units.

An official test made early in May on a run of 8 hrs. 32 mins. resulted in the burning of 37,550 pounds of mixed garbage, with an evaporation of 41,991 pounds of water, giving a rate of 1.12 pounds of water to 1 pound of refuse under working conditions, or 1.36 pounds of refuse to 1 pound of water from and at 212 degrees Fahr. The idea of building a destructor for its present combined purpose originated with Mr. F. L. Fellowes, town engineer of Westmount. Messrs. Ross & Holgate, consulting engineers, of Montreal,

FIG 1.—VIEW OF WESTMOUNT DESTRUCTOR AND ELECTRIC LIGHT PLANT.

The lighting plant is seen in the foreground and the refuse destructor house in the rear with the 150 foot chimney. The refuse is hauled to the top of the destructor house on the upper level. This picture shows how the engineers took advantage of the deep gulley to use the forced gravity in the process of garbage destruction.

supervised the erection of the plant on the Cost-Plus-a Fixed-Sum-Basis and worked out its details. Construction was begun last October and by April 1st the buildings, destructor and 150 foot chimney were in working order. From 1900 to 1903 inclusive the town of Westmount employed for refuse collecting, five horses and carts, five drivers and two stable men. During 1904 they collected about 6,500 loads The annual cost was $4,035.39.

In making his estimates for the present plant Mr. Fellowes provided for a brick and steel building, with charging platform of concrete and steel, stoking floor of concrete, a refuse tipping platform, house of wood encased with sheet iron and a twenty long-ton garbage hopper. In arriving at the capital cost and charges the electric lighting plant was charged with one-half the cost of the destructor, house and boiler. It was calculated that in one year the destructor would consume refuse equal to 1042 long tons of coal and therefore 1000 tons of coal at $4.00 a ton were credited to

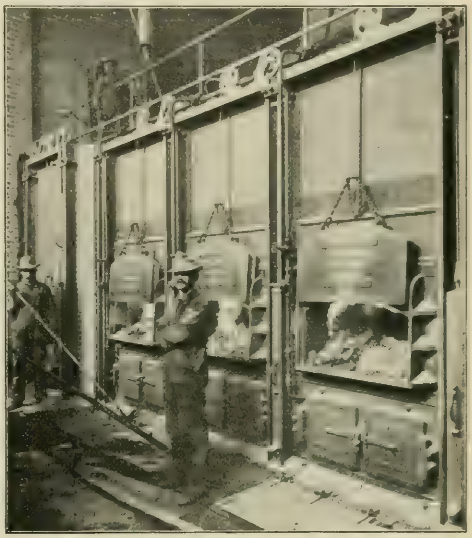


FIG. 2.—FRONT VIEW OF WESTMOUNT REFUSE DESTRUCTOR.

This picture shows the three destructor grates with the doors lifted to give a view of the fire within. The refuse is dropped into the grates from the hopper which discharges in top of the destructor.

thy operation of the destructor. Mr. Fellows' second preliminary estimate follows :—

		Interest 4	Depreciation 5	Repairs
Land....	$13,660	$ 546.40	$ 950 00	$285.00
Incinerator......	19,000	760.00		
Foundations......	3,000	120 00		
Buildings......	3 500	140.00	175 00	52.50
Ry. switch, scales, bldgs, etc.......	16,408	656 32	820.40	246.12
	$55,568	$2,222.72	$1,045 40	$583.02

Operating Expenses.		Credit 1,000 tons of coal.	
Interest......	$2,222.72	By sale of H.P. energy to lighting at $4.00 per ton......	$4,000.00
Depreciation	1,045.40	By clinker sold to road and walks	250.00
Repairs......	583.02	Credit ...	$4,250.00
Two laborers	930.00		
One stoker.	730.00		
One cart and horse......	637.00		
	$7,057.74	Tons destroyed per year	6,476
Credit....	4,250.00	Total operating expenses.	$2,807.74
	$2,807.74	Cost per ton.	13.3 cts.

The cost of cartage and collection under the old system averaged 62.3 cents a ton, while under the new system the cost is reduced to 52.4 cents a ton, by the elimination of one horse and cart; the cost of destruction, 43.3 cents a ton added to cost of garbage collection gives 95.7 cents as the total cost per ton.

Messrs Ross & Holgate in giving estimates for the electric lighting plant submitted the following fig-

ures:—Population of town, 11,000; number of houses, 2000; arc lamps for streets, 150; plant to accommodate 2000 houses. They estimated the capital outlay including 10% for contingencies at $129,884 for the electric lighting plant, and $67,175 for the refuse and power plants, giving a total of $197,058. It is extremely probable that the actual amount finally expended will fall considerably short of this figure.

The accompanying illustrations show the exterior view of the combined plant and the front view of the destructor proper with stoking and ash pit doors and trap doors for clinker. The buildings are situated in a hollow and great ingenuity was shown by the engineers in taking advantage of the lay of the land in order to utilize the force of gravity throughout the process of garbage destruction. The carts haul the refuse to the tipping platform far above the level of the grates into which it is dropped from the hoppers. The clinker is removed by wagons from the lower level. The refuse hopper which discharges into openings on top of the destructor, as seen in figure 2, is made of steel with lifting doors at its base close to the feed holes in the destructor. In the rear of the destructors are doors to enable the feeders to push the refuse in to the hottest portion of the fire without keeping the front doors unnecessarily open. The waste gasses from the burning refuse after firing the boiler pass through a series of staggered cast iron pipes about which air drawn from the room is kept circulating; after being heated by passing about these tubes the incoming air is carried through brick ducts to steam-jet blowers under the grates of the incinerator where the heated air (of a temperature of between 300 and 400 degrees Fahr.) is forced through the grate bars by the blowers.

The second function of the plant, that of supplying electricity to the town, is cleverly worked out in conjunction with the incinerating. In addition to the gas-fired boiler there are two others fired by hand with coal, this being necessary because of the insufficient supply of refuse. The steam from all these boilers feeds a common main which passes from the boiler house to the lighting station across a fifteen foot roadway. The generating units consist of three vertical cross-compound condensing high speed engines made by the Robb Engineering Company, of Amherst, Nova Scotia, directly coupled to 2,300-volt, 60-cyle three-phase alternators of Crocker-Wheeler make. Two of these units have a full load capacity of 200 kilowatts with an overload rating of fifty per cent. the third being a 50 kilowatt unit of similar characteristics. Provision has been made for the installation in the same building of a fourth unit which will double the capacity of the plant, the present equipment of boilers being sufficient to handle the additional unit.

The station is now furnishing electric light to private citizens of Westmount. When it is in full running order the plant will furnish all the light required for both municipal and private use in the town. The price will be lowered as the number of customers increases and it is expected that the rate per kilowatt hour will eventually be eight cents.

The following is the report made by Messrs. Ross & Holgate on the test referred to earlier in this article:

REPORT OF TEST OF MUNICIPAL REFUSE DESTRUCTOR, WESTMOUNT, P. Q., MAY 3RD, 1906.

W. L. Lee, Esq., Chairman Light Committee, Westmount:

DEAR SIR:—Since April 12th, 1906, the refuse destructor built by Messrs. Meldrum Bros., in connection with your municipal lighting plant, has been successfully destroying all refuse brought to it, in quantities averaging about 30 loads per day, the average weight of a load being about 1,500 pounds. This has usually been burned in 10 to 12 hours, giving an average burning capacity to the destructor of about 4,500 lbs. per hour, or a little over two tons. During several days this amount has been exceeded, and we have therefore no hesitation in saying that the maker's guarantees of 50 tons per 24 hours can be attained with proper firing. In order to officially test the plant, however, on May 3rd, a staff of our engineers went to Westmount, and conducted a special test run as follows:—

OBJECT OF TEST:—The test was conducted to try the burning and evaporative powers of the Meldrum Bros. three-grate refuse destructor when fired with unscreened mixed refuse, and connected to a Babcock & Wilcox boiler of 2,197 square feet of heating surface, and also to test the maker's guarantees regarding completeness of combustion, quality of residual clinker, temperatures in various parts of the destructor, etc., etc.

APPARATUS USED:—The following apparatus and instruments were made use of:

1. Meldrum destructor with regenerator, steam jet blowers, etc.
2. B. & W. water tube boiler, of 2,197 square feet heating surface, and with superheater and the necessary pipes to engine, atmosphere, etc.
3. Orsat apparatus for analyzing flue gasses.
4. U-tube gages for ash-pit pressures and chimney pull.
5. Dial thermometers for gas temperatures entering and leaving regenerator.
6. Stem thermometers for hot air, cold air, and feed water temperatures, etc.
7. Aneroid barometer for atmospheric pressure.
8. Public standard scales for weighing refuse, clinker, tins, etc., and also for calibrating the barrels used for measuring the feed water.
9. Knowles 6 x 4 x 6 duplex pump for feeding boiler, equipped with Williams Gage Co.'s automatic feed regulator.
10. Watkins heat recorders for combustion chamber temperatures.

DURATION OF TEST:—The test proper commenced at 10 a. m. and ended at 6.32 p. m., or continued for 8 hours 32 minutes.

CONDITIONS OF OPERATIONS:—Weather: Wednesday, May 2nd, was raining all day and all night. Thursday, May 3rd, was raining in morning until 11.30, when rain stopped and wind got up. Afternoon was warm and sunny.

APPARATUS:—The destructor gases fired the B. & W. boiler and the steam was used to drive a 130 h. p. Robb Engineering Co.'s simple non-condensing engine belted to a temporary 75 k. w. monocyclic generator carrying the day load of the town, which is a purely residential district, and therefore has a light day load. As this was light the whole power was not used, and the steam was blowing off to the atmosphere from the boiler almost continually.

MEN:—The following staff comprised the personnel of the test: Four men operating the destructor, one man attending to feed water, one man reading pressures and temperatures, one man checking weights and measures and taking gas analysis, one superintendent of test.

METHOD OF MAKING TRIAL:—The corporation (municipal) carts dumped the garbage into the large storage bin which had been cleaned out over night, and gave the checker the weight ticket as the cart was emptied. All large tins and unburnable refuse were picked out and put to one side and weighed separately afterwards. Fires were started at 7.55 a. m. with a light supply of old wood and a little coal, on clean grates, and kept in until 9.50, when the first weighed loads were dumped into the hopper. Firing with garbage commenced at 10 o'clock with the destructor warmed up, two men raking the refuse from the bin into the charging holes, and two men at the same time levelling the charge from the rear. Each fire was charged in turn, its steam blast being shut off during this process. After burning for about two hours (during which period fresh garbage was added to each fire every 20 minutes), the mass was thoroughly clinkered and it was then withdrawn from the front and dropped through the floor into the clinker pit below, whence it was removed to be weighed. Tins, etc., were also deposited in this bin for weighing. Fires were each clinkered three times. When the fires were well burned down and ready to clinker for the third time the test was ended, the burnt clinker being left on the grate bars over night to keep the destructor warm for the next

day's operation. This clinker was drawn and weighed the first thing Friday morning.

The boiler was fed through the Knowles pump and Williams regulator, and the level of the water in the drums was maintained practically constant through the test. The water for the test was pumped from a barrel submerged in the hotwell and fed from two barrels arranged so as to be filled and emptied alternately. The quantity was very carefully watched, and the barrels gaged very closely. Readings of pressures and temperatures were taken every twenty minutes, gas analyses were taken several times during the run, and combustion chamber temperatures were read about six or seven times under different conditions. At the end of the trial the conditions were as nearly as possible the same as at the beginning, the water level in the boiler being the same, as well as in the hotwell, and all other conditions were carefully watched and attended to.

RESULTS OBTAINED:—The following table shows in condensed form the averages of the results obtained :

Duration of test	8 hours 32 minutes
Number of cells	3
Total grate area	75 square feet
B. & W. boiler, heating surface	2,197 " "
Refuse consumed, (composition of waste material)	
Garbage, manure and leaves	15%
Ashes and unburnt (anthracite) coal, cinders, etc.	65%
Iron, wood, bottles, tins, leather, etc.	5%
Refuse, including paper, branches, old furniture, etc.	15%
Total	100%

WEIGHTS.

Unscreened refuse, rubbish, garbage, manure, etc.	38,090 pounds
Tins, etc., not burned	540 "
Net amount consumed	37,550 "
Refuse consumed per hour	4,402 "
Refuse consumed per hour per square foot of grate	58.7 "
Weight of clinker remaining after combustion	15,880 "
Percentage of clinker and ashes to refuse consumed	42.1%

WATER EVAPORATION.

Total water evaporated	41,991 lbs.
Water evaporated per hour, actual	4,920
" " " from and at 212° Fahr.	5,970
" " lb. of refuse, from and at 212° F., and per sq. ft. of total heating surface per hour	2.72
Water evaporated per lb. of refuse, actual	1.12
" " " " from and at 212° F.	1.36

PRESSURES AND TEMPERATURES.

Temperature of outside air average	55° F.
Barometric pressure average	29.5 ins.
Average steam pressure	123.5 lbs. sq. ins.
Average pressure in ashpits	1.74 ins.
Average vacuum at chimney base	9/16 in.
Average temperature of combustion chamber over 2,318 F. (Copper melted in 1¼ minutes—wrought iron was also fused.)	
Lowest temperature in combustion chamber	1,742° F.
Average temperature of air entering regenerator	75° F.
Average temperature of air leaving regenerator	206° F.
Average temperature of gases entering regenerator	427.5° F.
Average temperature of gases leaving regenerator	333.7° F.
Average temperature of feed water	47° F.

GAS ANALYSIS.

Percentage of CO_2 average of six readings	10.9%
Percentage of CO_2 highest reading	13.6%
Percentage of CO_2 lowest reading (clinkering fires)	4.5%

TIMES.

Time taken to clinker one grate	10½ min.
Time between clinkerings	2 hrs. 48 min.
Time each fire was clinkered	Three.

REMARKS:—A delay of about three-quarters of an hour was caused by non-delivery of garbage in the early part of the afternoon, during which time no fresh charge was added to the fire. Had this not been the case the total quantity of refuse could easily have been destroyed within eight hours, as the fires had to be held back somewhat on this account, and a somewhat better showing could have been made in the burning powers of the destructor had sufficient garbage been delivered to force it to its utmost capacity.

An interesting feature of the trial was the good feed water regulation; neither pumps nor valves being touched during the whole test.

Some idea of the great heat generated when the fires are in full blast may be obtained from the fact that at one time a piece of copper tubing 1½ ins. long by 1 in. in diameter by 3/32 in. thick was completely volatilized in 1¼ min., upon being placed in the combustion chamber, and a wrought iron horseshoe was picked out from the clinker heap which was fused in several places (wrought iron fuses at 2,912 F.) The same thing happened to an earthenware pot made of refractory material.

The clinker produced was hard and vitreous, and was fused into large masses of great density. Almost no smoke was visible from the chimney top, and all noxious gases were conspicuous by their absence. The analysis of the flue gases shows how complete the combustion was, except during the process of clinkering, when the large doors of the furnaces being open let in a large amount of air.

In consideration of the foregoing we are very pleased to state that in our opinion the destructor has fulfilled all the requirements of our specifications, and has also demonstrated the maker's guarantee satisfactorily, and we have much pleasure in recommending its acceptance.

Trusting that the above will meet with your approval, we are,

Yours faithfully,

ROSS & HOLGATE,

Consulting and Supervising Engineers.

80 St. Francois Xavier St., Montreal, May 4th, 1906.

In response to a request for a statement of capital cost and conditions and cost of operation of the destructor Messrs. Ross & Holgate have sent to us the following information :

CAPITAL COST OF DESTRUCTOR.—It is almost impossible to say at this date what the cost of the buildings, land, bin, etc., fairly chargeable to the destructor itself will be, as the whole equipment of the boilers and destructors together with coal and garbage storage and the necessary accessories, is contained in one building which is as yet unfinished and whose cost has not yet been separated, but the following items are approximately correct :

Meldrum three-grate destructor, about	$14,000.00
B. & W. water-tube boiler connected to destructor, about	4,500.00
Custodis chimney, total cost, about	6,000.00

(Only partly chargeable to the destructor, as it is common to all three boilers.)

OPERATING EXPENSES:—There are four men employed in the operation of the destructor for feeding, leveling and clinkering, as well as looking after the boiler. The wages paid are :—One man at 25 cts. an hour and three men at 20 cts. an hour. The 20 long tons of garbage per day are disposed of in about ten hours, so that at present only one shift is required and the labor change for destruction amounts to about 42½ cts. per long ton. Of course, there will be quite a considerable amount of steam sold to the electric plant which must be credited to the destructor and some clinker and other by-products will also be sold.

NET UNIT COST:—To obtain the net cost of destruction the capital charges and labor costs must be added, and the sum of the amounts obtained from the sale of steam and by-products subtracted from the total. The net costs so found, divided by the tons consumed per year, will give the average cost per ton.

The Northwest Power Company, Limited, capital $10,000, has been incorporated by the British Columbia Government.

Sir Adolphe Caron and Senator Domville went to Europe recently in connection with the financing of an electric railway from Montreal to Midland. Sir Adolphe Caron has returned and reports that the British financiers regarded the project favorably.

The Town Council of Kenora, Ont., have obtained permission to develop the water power of the Winnipeg river at a point near that town and the ratepayers have approved of a by-law to provide $200,000 for the work. The plans of the proposed development have been prepared by T. Pringle & Son, Montreal.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Blast Furnace Gas. The immense volume of gas emitted from a blast furnace has always been used to a certain extent in direct connection with such work, in two ways, namely, in the Cowper stoves which heat the air supplied to the furnace, and under the boilers which generate steam for the pumping engines. An immense quantity of this gas is invariably wasted, it being of a very low grade, and no additional uses having presented themselves. It is just eleven years ago that the first attempt was made to untilize blast furnace gas directly in gas engines, and while a little success was met with at that time, the engine itself was not sufficiently developed, neither in the method of its operation nor in size, to make possible the economical utilization of such gases. The strides made in the development of gas engines compare very favorably with the remarkable advancement experienced in the design of electrical apparatus, and to-day gas engines of immense power are being operated with blast furnace gas, and their energy is being transformed in many instances into electricity. It is an astounding fact that to-day in Germany gas engines for use in connection with blast furnaces are built or are on order with an aggregate rating of almost half a million horsepower. We might say in explanation that these engines will not be used entirely on blast furnace gas, but are also intended for use in conjunction with coke ovens, though we understand the great majority are intended for blast furnace installations. The possibilities of obtaining power from this hitherto practically unused source will be appreciated when one considers that a three hundred ton blast furnace wastes gas which is capable of generating over four thousand horsepower. The industrial world must soon face the problem of fuel economy, and while water power is one solution of this difficulty, still every possible waste which now exists must be considered. In the blast furnace we have a device which of necessity gives off large volumes of this gas, and in the gas engine as it is to-day developed, we have a means of utilizing this waste.

Individual Motors. Engineers are daily encountering the problem common to all electrically driven shops, of individual or group motor equipment. This question is one which undoubtedly demands individual study, and it is difficult, if not impossible, to lay down fixed rules. In a factory of any size it is an accepted fact to-day that with very few exceptions the motor drive will result in a material economy. This result is due to three causes, first, the ability to place more tools within a given area; second, the lesser amount of power required for driving such tools; third, the increased output which can be obtained due to the advantages of variable speed. The use of very small motors is not to be recommended except under conditions where individual control of some particular tool is absolutely essential, and under such circumstances no choice is offered as to the method of drive. Then there are other tools which require larger amounts of power, and these lend themselves most naturally to individual motor equipment, for not only are the motor sizes such as to make it advisable to install separate machines, but the variable speed feature will in many cases be a necessity. In every factory there will be

certain machines which can be classified as constant speed, and it is with such machines that the group drive can be adopted to advantage. An article on this same subject appeared in our columns some months ago, and figures were quoted which made a very interesting comparison between the aggregate horsepower of the motors installed and the total load on the plant, as shown by the power house meters. Another case has recently come to our notice where about thirty motors, many of which are very small, are installed, having an aggregate horsepower of one hundred and fifty. The power house load does not exceed twenty-five kilowatts, and the ammeters are remarkably steady at this point. The class of work is such that variable speed is an absolute necessity, and about one-third of the motors are employed on work which requires the constant stopping, starting and reversing. In spite of this fact, the ammeter needles seldom show more than thirty kilowatts, and very rarely indicate less than twenty. This maximum point is usually in the form fo a kick occasioned by the starting of a heavy freight elevator, and really cannot be attributed to the regular motor equipment of the factory. This particular shop, prior to the present design being adopted, was driven throughout by means of complicated speed changing devices which were in frequent need ot repair. At that time the aggregate power, as represented by the tools installed, did not exceed one hundred horsepower, and if we remember the figures correctly, the power house load was seldom below one hundred and twenty-five indicated horsepower. From the above, one can readily appreciate the advantages of electric drive as it has been applied to the case in question. While the tools have been increased only fifty per cent., the output of the shop shows an increment of almost one hundred per cent. and this with a very material decrease in the power bills.

Transmission Lines. In countries where climatic conditions limit the strains which may come upon the poles of a transmission line to wind strain and the weight of the wire, it is pretty safe to say that the use of steel towers, set up to six hundred feet apart, is advantageous when compared with wooden poles and considerably shorter spans. Assuming that the towers for the long spans, and the wooden poles for the short spans, incorporate a sufficient element of strength to withstand any strains which may be placed upon them, the troubles experienced in transmission systems may be attributed to the insulator. When used with high voltages, the insulators are usually of sufficient mechanical strength to carry any strain which may be placed upon them, and it therefore seems logical to use as few insulators as possible, and hence the long span transmission line has one point very much in its favor. In warm countries the life of the wooden pole is considerably shortened by the attacks of insects, and therefore the steel tower has many advantages. It is a simple matter to design a transmission line to withstand a given velocity of wind, assuming that such wind blows at right angles to the line, and that this maximum velocity occurs during a time of minimum temperature. In southern countries the temperature variation is known almost to a certainty, and the transmission engineer therefore has before him a fairly simple mechanical problem. In northern latitudes, the question of excessive varation in temperature must be considered, and with it the possibility of sleet formation. This latter, of course, requires the most careful consideration, and is at best an uncertain quantity. The temperature variation in northern countries is really more marked than in the south, and hence the transmission line located under the conditions of the former will be subjected to considerably greater strains. The long span, therefore, does not lend itself with the same facility to northern installations, and while in many instances it is possible that the steel tower construction with long spans would compare favorably in price with cedar poles on short spans, still the close spacing required practically prohibits the tower construction. Again, cedar usually can be obtained at a very low price, and the quality of the pole is generally good. With the cedar pole, of course, there is always a doubt as to the life, and the cost of replacing broken poles and the damage which may occur to a line due to such breakage, is a matter requiring most careful thought. Cedar poles seem to give out just at the ground level, and therefore many suggestions have been made to prevent the rotting of the lower portion. Various chemicals have been applied under pressure, or in a vacuum, with a certain amount of success, but the treatment prolongs the life of the poles only a few years at the best. In France there has recently been some interesting experimenting carried out with a view to overcoming this weakness of the wooden pole, and cement has played a prominent part in the work. We understand that in these experiments the idea of setting the pole in a cement pocket, or in a cement foundation, has been discarded, and in its place has been adopted the scheme of putting into the ground a cement butt, and mounting the pole upon and above this butt. As we understand the matter, the concrete butts are made in ordinary wooden forms, and meta plates are placed inside the form prior to the introduction of the cement. These plates project above the top of the concrete some little distance, and the pole is set in the centre of such plates, and is bolted through. A space of about two inches is left between the actual base of the pole and the cement butt, and the butt is set in the ground with its top some eight or ten inches above the grade line. In this idea we have a cement butt in the ground, the life of which is practically infinite. The pole itself, at its lowest point, is a foot above the ground, and is attached to the cement in a strong and substantial manner. Therefore, in place of breaking in the lower portion, all parts of the pole will have an equal life, and it would be safe to say that poles set up in this manner would have a life at least double that of poles set in the ground. Another strong point in favor of this construction is that the replacing of a broken pole is a very quick and simple process, and therefore one of the most objectionable features in connection with wooden pole construction is eliminated. The cost of the concrete for such a base should be very small, inasmuch as in the construction now used the base has but a slightly larger diameter than the butt of the pole. Apparently in France these cement pole butts have been made at one central point, and after they have hardened, have been transported to their point of use. Probably this method would be modified should it be adopted in this country, but in any event we do not think the cost would be prohibitive, especially when the longer life of the pole is taken into consideration.

The Ontario Power Company of Niagara Falls

By V. G. Converse, Electrical Engineer Ontario Power Company.

Briefly outlined, this company's development comprises the taking of water from the upper Niagara River, leading it through pipes and penstocks to turbines in a station below the falls and there utilizing its energy for the generation of electricity which is transmitted to a second station on the bluff above and thence distributed.

Starting from the headworks, the water is diverted under curtain walls into two forebays in series, so proportioned as to provide the proper velocity through screens and gates, and so constructed as to exclude ice. From the inner or second forebay the water is conveyed in large conduits underneath the ground, along the outskirts of Queen Victoria Park for a distance of approximately one and one-quarter miles to a point adjacent to the Horseshoe Falls.

At the terminus of the eighteen-foot conduit now completed, nine-foot steel penstocks equipped with gate valves extend first vertically and then horizontally, each to a turbine unit in the generating station. This building is nearly on a level with the river below the Falls, and is as close to the cataract as conditions allow. It is to be noted that the full head of the water between the upper and lower rivers has been acquired so far as was feasible from an economic standpoint.

Each generating unit consists of a horizontal double turbine direct-connected to a generator. The units are alike in appearance, but the fourth, or last generator installed, possesses an advantage over the others in a twenty per cent. increase of capacity. The completion of the station and the equipment of it will be but an extension of the present form until, according to existing plans, there is an installation under the one roof sufficient for the continuous delivery of 200,000 horse-power of electrical energy.

From the generating station the electric current is carried by underground cables to the distributing station on the bluff, 260 feet above and 600 feet back from the generating station. In the distributing station are the switching and transforming apparatus and the metering and controlling devices for the operation of the plant. From the distributing station go the overhead circuits of various voltages for the transmission of the power to the consumer.*

The hydraulic portion of the plant and a part of the generating equipment having been in service for nearly a year, it is befitting to remark that in general the plan of the headworks to exclude ice, the operation of the

Fig. 1.—View of Head Works, Ontario Power Company.

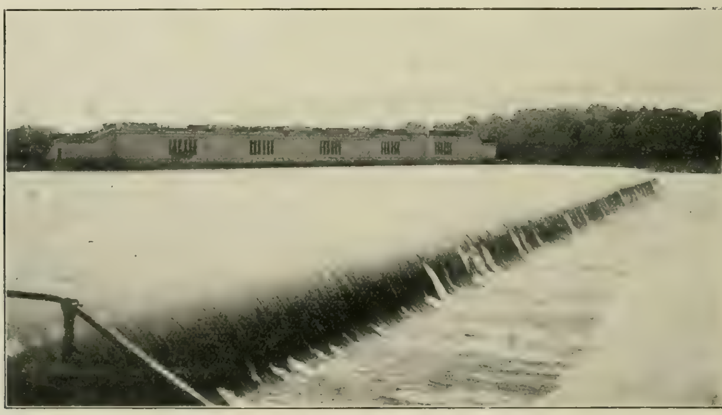


Fig. 2.—Overflow of Outer Forebay, Ontario Power Company.

*For complete general description of the Ontario Power Company, see paper by Mr. P. N. Nunn, Engineer, presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, North Carolina, June 19-23, 1905.

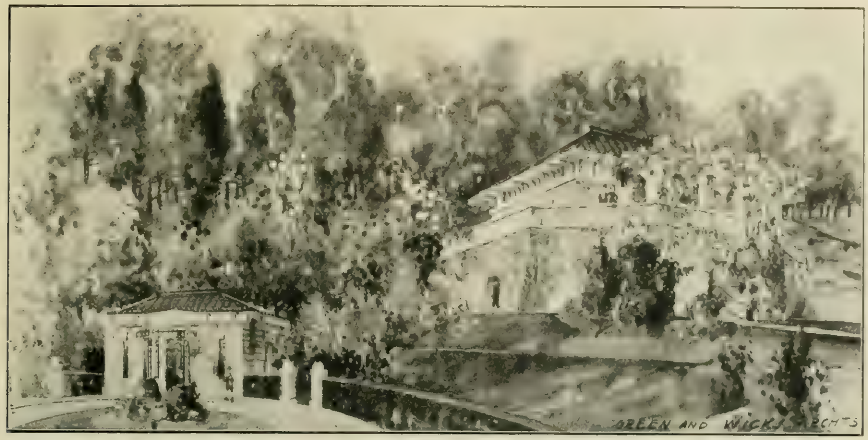


Fig. 3.—Entrance and Spillway Buildings, Ontario Power Company.

Fig. 4.—Generating Station, Ontario Power Company.

Fig. 5.—Interior of Generating Station, Ontario Power Company.

[illegible] with its spillway, the location and action of gates, valves and reliefs for the water, together with the results obtained from turbines and generators, have proven most satisfactory. That all of these features have been put into use without a single difficulty, and have perfectly performed their various functions, is but the logical outcome of the careful study, painstaking attention to detail, and thorough execution of this portion of [illegible]

and overflow buildings at the terminus of the main conduit. Their erection, which of necessity has been delayed to the last, is in progress and very pleasing buildings will shortly hide the present unsightly constructions.

It is the essential purpose of this paper to describe the electrical features of the Ontario Power Company's plant, to which attention will now be directed. Three generators of 10,000-H.P. capacity each, and a fourth of 12,000-H.P. are now in service. These machines are wound

FIG. 6.—DISTRIBUTING STATION, ONTARIO POWER COMPANY.

The coming month will witness the putting into service of the transformers, switches and other high voltage equipment of the distributing station, and the delivery of power to the enormous transmission system of the distributing company for use throughout western New York, and somewhat later will come the electrification of the circuits now building for the delivery of power to the Niagara district of Canada.

Much has been said of the disfigurement of the park by the power plant construction, and this with considerable

FIG. 7. VIEW IN LOW TENSION BUS ROOM, BUS SIDE.

justice, but to one who now sees the construction nearing completion, and notes the new channels and islands at the Dufferin Inlet, the provisions for the observation of the rapids and falls, the harmonious character of the buildings, and the general air of fitness and refinement, it cannot but appear that the retention of the beauty of Niagara has been in mind as well as its exploitation for power. At present the only exceptions are the entrance

for three-phase current at 12,000 volts, and 25 cycles, and have revolving fields, the speed of rotation being 187.5 R.P.M. The total weight of a generator is 231 tons. Assembly, including the building up of the laminated iron of the rotor, and the winding and insulating of the armature, has been done entirely upon the ground.

FIG. 8.—VIEW IN LOW TENSION BUS ROOM, BETWEEN BUSSES.

Two exciters have been provided, each of 500-H.P. capacity at 250 volts, and driven by its own turbine. A single exciter is of sufficient capacity for the fields of six generators.

The leads from the generators are single conductors, insulated with treated cambric. These leads, each in a separate compartment, are mounted on porcelain insulators, ample clearances to ground be-

ing allowed on all sides. The compartments are built up of thin shelves of reinforced concrete, secured to the concrete sub-structure of the building, and are closed by doors of asbestos which may be readily removed for in-

Fig. 9.—Low Tension Switch Room.

spection. At no place are the leads of more than three generators brought into proximity, and the leads of each set of three generators where they approach their respective oil switches on the gallery in the generating station are so protected and isolated from each other that grounds or short circuits would seem to be impossible.

Field circuits, exciter leads and control wires are carried in iron conduit and are either in separate passages or at respectful distances from power wires.

The electrical equipment of the generating station, aside from the machines, consists of a switchboard, having a panel for each generator upon which are mounted an electrically controlled field circuit breaker, an ammeter, and a control switch for tripping the first generator oil switch; also a panel for each exciter, containing the customary switches, and a voltmeter and ammeter. Secondary to this board is another panel board for the distribution of alternating and direct current for the light and

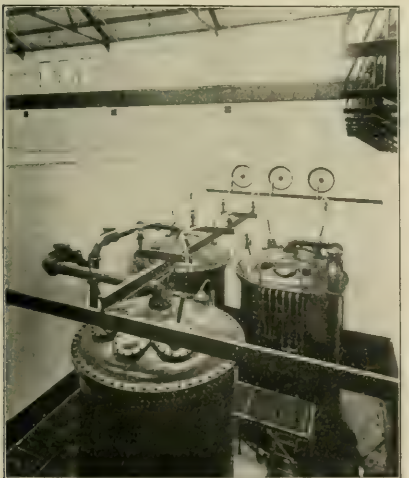


Fig. 10.—View in Transformer Room.

power service in the station, and also for the distant control of the valves in each turbine penstock. Back of the exciter switchboard are small panels, one for each pair of generators, on which are mounted the terminals of the control wires and the relays for the automatic operation of the oil switches.

There are also the generator oil switches, field rheostats, and small motors on the turbine governors all of which are controlled from the distributing station.

The detail electrical equipment of the station is simple, and being wholly on the operating gallery is within easy access of the operator. Ordinarily the operator is required to merely attend to the supply of exciting current,

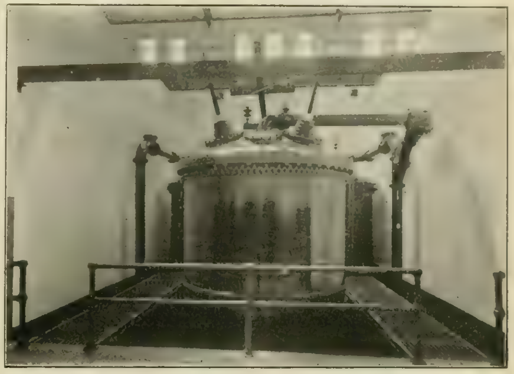


Fig. 11.—A Transformer Compartment.

but in case of a destructive short circuit on a generator or other serious trouble, the control of the first generator oil switch and of the field switch is at his command.

The outgoing generator leads from the oil switches go to cable heads supported and isolated in a substantial manner, directly under the floor supporting the switches. Here change is made to three-conductor cables, two being required for each generator. They are paper insulated and lead covered, having outside of the lead a spiralled steel ribbon armor imbedded in and covered with jute.

Thus far the electrical construction is of conventional form, but arranged and installed with due regard for ease of inspection, the isolation of power circuits, and the logical grouping of apparatus.

The necessity for the location underground of the three-conductor generator cables and the various low voltage control circuits leading to the distributing station, presented new problems which were met in the following manner. A tunnel approximately nine feet square with arched roof was cut through the rock. This tunnel starts on a level with the main floor of the generating station, extends through the rear wall and rises at an angle of thirty degrees until it has passed under the main water conduits. For this portion of the distance it accommodates the two thirty-inch penstocks for the exciter tur-

Fig. 12.—High Tension Busses and Line Outlet.

bines. After passing under the main conduits it rises at an angle of sixty degrees and opens into a manhole half way up the bluff to the distributing station. The difficulties were to support the three-conductor power cables and yet to isolate them and to provide for their easy drawing both in and out of the ducts.

After the tunnel was cut through it was lined with brick, an offset being left in each side wall of sufficient height to accommodate ten vertical courses of tile ducts, secured in place by steel ties and a facing of concrete. At frequent intervals in each duct course a tile was omitted. In the openings so formed iron clamps with wooden bushings for gripping the cables were secured by bolts to the rock wall. The requirement for such support will be seen when it is understood that a

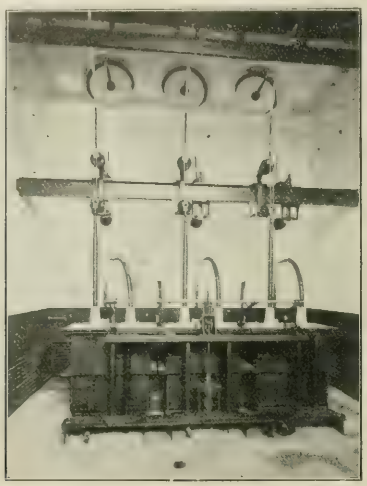


Fig. 13.—High Tension Oil Circuit Breaker Compartment.

generator cable weighs thirteen pounds per foot, and for the length of the tunnel exerts a downward force of over a ton.

The control cables for the operation of the governors, field switches, rheostats, oil switches, exciters and penstock valves are carried in iron conduits secured by hangers to the roof of the tunnel. These conduits are interrupted at intervals to allow the admission of a wood bushing which clamps the cable and bears against the end of the conduit to assist in supporting the cable. The exciter penstocks are located on the floor of the tunnel and support a stairway which affords easy access.

The tunnel construction practically equals in its efficacy the standard underground tile system. The present tunnel will accommodate the necessary cables for six units and extra cables for two units to be used in case of emergency. Two other cable tunnels will be required for the complete plant.

Fig. 14 Terminal, Relay, and Recording Instrument Boards, Switchboard Section.

After leaving the manhole at the terminus of the cable tunnel, the cables are carried in three groups of tile ducts buried in the ground, the two outside ones being for power cables, and the inner one for control cables. The construction is of the standard form, though somewhat involved by several curves due to the contour of the ground, and the different relations of cables in the manhole and duct systems.

From the duct courses the cables are taken into a distributing manhole at the front of the distributing station. Both this manhole and the one at the terminus of the cable tunnel have separate chambers for the control and power circuits. Manholes allow of a straight passage of the cable through them, and reinforced concrete shelves of construction similar to that described in the generating station furnish both support and isolation for the cables and splices.

From the distributing manhole any generator cable may be drawn through a manhole and duct system along the

Fig. 15.—Control Room.

front wall of the distributing station, and connected to any unit in the station.

The distributing station arrangement cannot but be regarded as both novel and unique, and a few of the considerations which have led to its design, may be of interest. In the first place it was impossible to comprehend all of the conditions which might arise in the distribution and utilization of 200,000 horse-power. Unlike the generating station with its similar units, the distributing station would undoubtedly be required to provide for the delivery of power both at generator voltage for use in the immediate vicinity, and also at voltages higher than that of the generator for long distance transmissions. The delivery of power at generator voltage, however, would require but a comparatively small amount of space for the necessary busses, switches and lightning arresters, while the delivery of power at higher voltages would require, besides switches and busses for the generator voltage, a considerable amount of space for transformers and

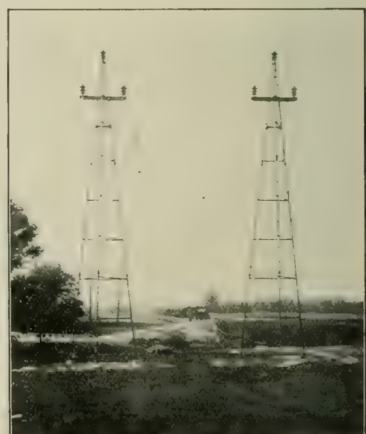


Fig. 16.—View Along Tower Lines.

high voltage equipment. In fact, the required ground space for a high voltage unit is over ten times that for a unit of the same capacity at generator voltage.

It was thus evidently impracticable to commence the construction of this building at one end, as was possible with the generating station, since the combination of low

and high voltage unit spaces as they might be required would probably lead to either a very irregular building, or else one with considerable waste space. The assumption was therefore made that the output of six generators was the maximum amount that would be required for delivery at generator voltage. This capacity required such a length of bus for switch connections as might very properly be devoted in the length of the building to the switchboard and control equipment. Likewise the width of building required for the switchboard equipment in addition to that required for the low voltage units corresponded very closely to the width required for high voltage units. Consequently the switchboard section is located in the centre of the building with switches and busses of low voltage units in front of it, and their lightning arrester and selective switch equipment in the rear, the outgoing low voltage feeders passing underground beneath the switchboard section. The low voltage switches and busses of the high voltage units occupy the same position relative to their respective transformer sections as do those of the low voltage units to the switchboard section. This arrangement allows a continuous low voltage bus and switch room, also a continuous high voltage bus and switch room, and subdivides only the high voltage transformer equipment, which division possesses some considerable advantage.

Fig. 17.—A Single Insulator Tie.

The distributing station is then the locus of the control and distribution of all power from the generating station. With its present dimensions it will accommodate besides the switchboard and control apparatus for the complete development, the equipment for handling the output of fourteen generators, provided that six deliver power directly to the transmission lines. The extensions to the building will be on each end and entirely for high voltage units.

That arrangement of the power circuits which would be best adapted to the character and future requirements of the plants was open to equally as much doubt as was the design of the building itself. The arrangement which has been adopted is shown in the accompanying diagram of power circuits. It is believed that it possesses a flexibility sufficient to meet any requirements that may arise.

It will be noted that there are two busses for low voltage and one for high voltage. All have links or tie switches to break their continuity on each side of their junction with a unit. Generators may be parallelled on either of the low voltage busses, and when so operated may supply the high voltage bus through the transformers. When operation in this manner has been effected the generators may be disconnected from the low voltage busses. The cross-connection of generators to either low voltage feeders or transformer units, is also possible with the arrangement adopted. By opening either the tie switches in the bus bars or the selector switches connecting to them, the station may be operated as a number of individual power plants.

The system is necessarily a unit one in the arrangement of its wiring, switches, transformers, and other apparatus from the generators through to the outgoing feeders, and is such as is best adapted to a trunk station of this character where there are only a comparatively few main feeders.

All switches feeding busses, both high and low voltage are equipped with overload and reverse current relays. Switches taking current from busses have overload and time limit relays. As previously stated the switch in the generating station can be opened by control at that point, but it can be closed only by the operator at the distributing station. When working automatically it opens in conjunction with the first switch in the distributing station.

With the ability to control switches from a distance and with the busses, switches, transformers and other apparatus located in the order of their sequence in the circuit connections, the distributing station houses a collection of symmetrical units with the various apparatus and constructions for each placed in regular order, and either isolated by barrier walls or separated from each other by being in different rooms, according to the relative risks. The result is a harmony that cannot but be of advantage in the operation of the station, and a segregation that is of value in preventing interruptions of the service, both of which have been attained with an expenditure that is fairly proportionate to the results, and a simplicity that is apparent when seen, though difficult to describe.

The generator circuits entering the low voltage bus room and the feeder circuits leaving it are single conductor cables, the change having been made from three-conductor cables, in a manhole for each unit without the station wall. The conductors, insulated with treated cambric, are mounted on insulators and with their series transformers for the actuation of instruments and relays are isolated by vertical concrete barriers.

The strap copper busses are mounted in a horizontal position on the outer sides of two concrete division walls extending from the floor to the ceiling of the room. They are supported in and isolated by a structure quite similar to that described for the generator leads in the generating station. All connections to and from the busses pass through porcelain bushings into the space between the two main division walls, and thence extend vertically to the switches in the room above. They also are separated by concrete barriers, there being no two cables in any one compartment. Potential transformers for use with instruments are placed within the same central space, and are isolated with barriers of alberene stone, the front of their compartments being closed by asbestos doors.

The use of concrete for the almost entire construction of a bus structure is somewhat of an innovation, and the success obtained with it assures the continuation of its use. It is not only strong, easily erected and economical of space, but furnishes one of the best fire resisting mediums, and is comparatively inexpensive.

Fig. 18—Insulator with Clamp

In the low voltage switch room the oil switches are arranged in two parallel rows and separated into their unit groups. They are of the plunger type, actuated by direct current magnets. Knife switches in both incoming and outgoing leads, permit of their complete and assured disconnection from all circuits for necessary manipulation or adjustment.

The single conductor leads from the bus room to the low voltage feeders, and transformer units have the standard cambric insulation, but are lead covered and are carried underground in ducts.

In the transformer rooms, only one of which is at present completed, are located both the transformers, and the oil insulated choke coils, for their protection. The three transformers of a unit are of the oil insulated, water cooled type, connected in delta on the low voltage and in star with centre grounded on the high voltage side. The secondary potential of each transformer is 36,000 volts, and as connected the resultant line voltage is approximately 62,000. Each transformer has a normal capacity of 3,000 K. V. A., and weighs, complete with oil and case, approximately 50 tons.

Each transformer case is cylindrical in form, and the three constituting a unit, are arranged in a triangular group in a pit six feet below the level of the main floor. A travelling crane spans the room, and will handle any choke coil or transformer without interference with the operation of other units.

The necessary oil and water piping with its numerous valves, is carried in a space provided between the foundations underneath the floor of the pits.

The high voltage wiring from the transformers is insulated with treated cambric and further protected by a braided fire-proof covering of asbestos. It is supported on large porcelain insulators in the upper part of the transformer pits, the proper connections to the transformers being made through terminals issuing from the tops of their cases. The three outgoing leads, after connecting with the choke coils, pass into the high voltage room through insulating bushings set in the centres of circular wall panels. These panels are composed of two half-inch sheets of a fire-resisting, insulating composition.

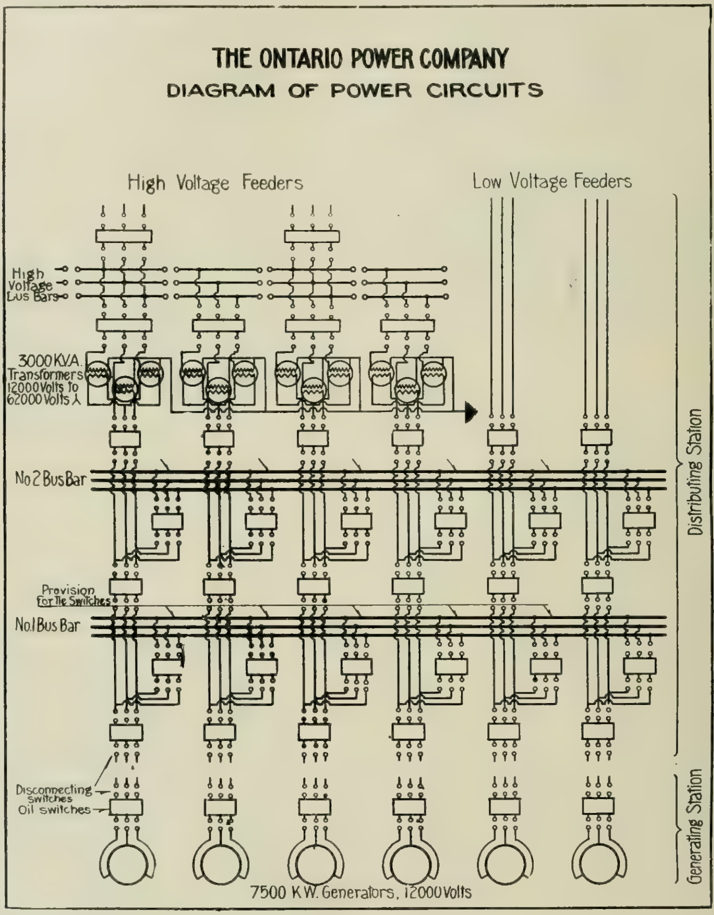


Fig. 19.—Diagram of Power Circuits.

Strong barrier walls rising to an elevation several feet above the tops of the transformer cases isolate each group of transformers and choke coils from adjacent similar groups. A lower wall separates each transformer group from its corresponding bank of choke coils. The track space extending through the building along the open side of the transformer pits provides room for assembly or repairs.

Besides the protection given to the groups of transformers by the barrier walls, each transformer case is so strongly constructed that in case of short circuits or combustion within it the expanding oil and gases will find relief to the sewer through an eight inch outlet pipe, without giving rise to pressure exceeding the strength of the case. While there is but little chance of continued combustion within a closed case of this type, cold oil may be admitted from the supply pipe at the bottom to flood the transformer if required.

In the high voltage room the switches and series transformers are on the floor and the bus-bars overhead. The latter are composed of copper pipe wrapped with treated cambric and asbestos braid, and are supported mainly by their tie switches which are mounted on the tops of high masonry walls which separate the units.

The wiring is done in the same manner as in the transformer room, there being a clearance of several feet between wires, but no other protection than distance and the insulation on the wire.

The construction and action of the high voltage switch is like that of the low voltage one, but it is considerably larger because of the longer break and greater insulating distances required for the higher voltage. The oil is in

large steel tanks, approximately five hundred gallons being required for a switch. Oil piping for the switches and control wiring for their actuation are carried underneath the floor.

In every alternate compartment are the switches and series transformers of feeder circuits, there being at present but half as many feeders as transformer units. Each wire of an outgoing feeder passes out of the building through an insulating bushing supported in the centre of a double glass panel set in an opening in the wall.

That portion of the high voltage bay which corresponds in length to the switchboard section is shut off from the high voltage busses, and serves as an outlet for the low voltage feeders and their accessory devices. In this room is also a secondary low voltage bus for the switching of power to the transformers supplying the light and power service to the plant.

The outlets in the exterior wall of the building for both high and low voltage feeders have their insulation protected from the weather by an overhanging hood.

Horn gap lightning arresters of generous proportions and with graded gaps and resistances are located in the rear of the station for the protection of high voltage feeders.

Low voltage circuits are at present carried on wood poles, the details of the construction embracing no particularly new features.

The high voltage circuits are in duplicate, and are carried on steel towers placed usually along a private right-of-way. The towers have a triangular base, tubular legs, and carry but the three wires of a circuit. A clearance of 30 feet is everywhere preserved between circuits. The construction is made especially strong with concrete anchorages, and the liberal use of guys at angles and crossings. The insulators are massive, and are mounted on steel pins. The transmission cables are of aluminum one and one-eighth inches in diameter, secured by ties or clamps as conditions require, and protected at the insulators against arcs by a serving of aluminum wire.

Having now traced the power courses from the generators through to the transmission lines, attention naturally turns to the control and measurement of the power.

The control room is located on the top floor of the switchboard section, at the most advantageous position for the observation of the apparatus in the distributing station. Control pedestals, corresponding in number to generator units, containing operating switches and pilot lamps, with indicating instrument stands directly back of them, are arranged in an approximate semi-circle around the room. The line is broken only at the centre to permit of the feeder control panels, located at the back of the room, being visible to the operator. The semi-circular arrangement allows ample clearance between units for their distinguishment, and also enables the operator to see every instrument from any position within the control area.

Each instrument stand has mounted upon it a voltmeter, ammeter, wattmeter, power-factor indicator, frequency indicator and synchroscope; also three ammeters connected in the leads to the transformers.

A control pedestal contains, besides the small switches for the control of oil circuit breakers, push buttons for opening and closing the generator field switch, a controller for the rheostat face-plate and a controller for varying the speed of the turbine through the medium of the governor. A diagram of circuits on the face of each pedestal, in which are placed pilot lamps from oil switches, enables the operator to comprehend at a glance his circuit connections.

Each feeder control panel carries the switches and pilot lamps necessary for the control of the oil circuit breakers in the duplicate feeders and three ammeters for each feeder circuit.

Opposite the semi-circle of generator and feeder controls are two service boards, one on each side of the entrance to the room. One of the boards contains the switches and instruments required for the distribution of alternating current at 220 volts for light and power purposes in the building; also the control for the oil circuit breakers located in the low voltage service bus. The other board contains the switches and instruments requisite for the distribution of 250 volt direct current (derived at present from one of the exciters) for lighting and control purposes. There is also a panel on this board for the control of a storage battery which serves as a relay for the 250 volt exciter control current.

On the three floors beneath the control room, arranged in the same semi-circular manner, there are in order the recording instrument boards, terminal and relay panels and assembly racks for control and instrument wires. The room containing the latter is in the basement, and, besides accommodating the wires, contains a cell for a sixty ampere-hour storage battery, and also serves as a distributing point for all oil, water and steam piping.

The control and instrument wires, grouped into cables according to the character of service, come into the assembly room on separate shelves for each unit from channels which are entirely isolated from the power apparatus. Here they rise to the terminal boards where there is a terminal and fuse for every wire. These terminal boards and the similar ones in the generating station furnish definite points for the detection of trouble in any control or instrument circuit. From the terminals the wires go to the switch relays or recording instruments, or to controls and instruments in the control room.

The graphic recording instruments are of a new type and comprise voltmeters, ammeters, wattmeters, and frequency and power-factor indicators. They are so connected in the low voltage circuits that there is a continuous record of each generator as well as of the demands of any set of feeders.

In the control room the chief operator's position is in the centre where, at his desk, he may observe, through his instruments, every electrical occurrence and direct his assistants as required. He has his own private telephone system running to all the rooms in the building, and also has direct connection with the telephones along the transmission lines. He may communicate with the generating station either by telephone or telautograph, the latter being almost exclusively used because of its unmistakeable records.

While unusual for the control operator to be away from the sound and sight of his moving machinery, it is believed that the design which necessitated it has been carried out in such a manner that the separation may prove of distinct advantage.

Of the principal electrical equipment of the plant, the wires and cables have been furnished by the Standard Underground Cable Company, Pirelli and Company, of Italy, and the Northern Aluminum Company, and the apparatus by the Westinghouse Electric and Manufacturing Company.

The electrical design of the plant has been in the charge of the writer under the direction of the Engineers, Messrs. L. L. and P. N. Nunn, and with the aid of an able corps of assistants, amongst which stand out most prominently the names of Mr. Paul Cheever and Mr. J. A Brundige.

MOONLIGHT SCHEDULE FOR OCTOBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Oct. 1	3 15	Oct. 1	5 15	2 00
2	No Light	2	No Light	....
3	6 10	3	8 10	2 00
4	6 10	4	8 40	2 30
5	6 00	5	9 10	3 10
6	6 00	6	9 45	3 45
7	6 00	7	10 20	4 20
8	6 00	8	11 00	5 00
9	6 00	9	11 50	5 50
10	6 00	11	0 40	6 40
11	6 00	12	1 40	7 40
12	5 50	13	2 40	8 50
13	5 50	14	3 40	9 50
14	5 50	15	4 50	11 00
15	5 50	16	5 30	11 40
16	5 50	17	5 30	11 40
17	5 50	18	5 30	11 40
18	5 40	19	5 40	12 00
19	5 40	20	5 40	12 00
20	5 40	21	5 40	12 00
21	5 40	22	5 40	12 00
22	5 40	23	5 40	12 00
23	5 40	24	5 40	12 00
24	10 00	25	5 40	7 40
25	11 00	26	5 40	6 40
27	0 10	27	5 40	5 30
28	1 10	28	5 50	4 40
29	2 10	29	5 50	3 40
30	3 10	30	5 50	2 40
31	No Light	31	No Light	....
		Total	....	210 25

Joseph Brodie, electrician for the C. P. R. at Fort William, Ont., was killed recently by coming in contact with a live wire.

The Manitoba Gypsum Company are building a new factory in Winnipeg, which will be operated by electric power from the Lac du Bonnet plant of the Winnipeg General Power Company.

Line Construction for Overhead Light and Power Service*

By Paul Spencer.

An electric light and power system can broadly be divided into three parts, the generation, the distribution, and the utilization of the current. The progress made in two of these departments, namely, the generating and the utilization of the current, has been constant and rapid. The greatest possible care and thought have been given to designing and building the power station and to its equipment with machinery that will insure uninterrupted service.

The improvement in the reliability of arc and incandescent lamps, of motors, and of all other appliances for transforming the current into useful work, has also been a matter for careful engineering study. But the central link in the chain, the distribution of the current from the power station to the consumer, has received much less attention.

Granted conditions where underground construction

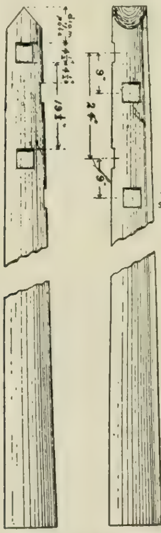


Fig. 1.—Pole Framing.

is economically feasible, the distribution problem stands a chance of intelligent consideration and of being satistactorily solved along engineering lines, with proper consideration given to reliability of service, freedom from accidents, safety to the public and employees, and the future growth and development of the situation.

But the possibility of underground distribution is limited to more or less thickly settled territories. Considering electric light companies as a whole, the largest extent of the territory covered must be reached by overhead lines. And when it comes to overhead distribution, the engineer seems to have thought the matter too trifling for his efforts, and to have left the problem to solve itself or to be worked out by the rule-of-thumb methods of the line gang.

The result is shown in the generally poor construction of overhead lines throughout the country and by the general belief that overhead service is much more unreliable than underground service,and is responsible, in a great measure, for the agitation in favor of placing wires underground, even in localities where the cost of the necessary underground construction is out of all proportion to the revenue to be obtained in the territory. The writer does not believe that the objections to overhead lines can be altogether eliminated. A pole line can never be said to be, in itself, an artistic creation, a thing of beauty, or an ornament to the landscape; but with more care given to the construction, such lines can be made safe and reliable and their

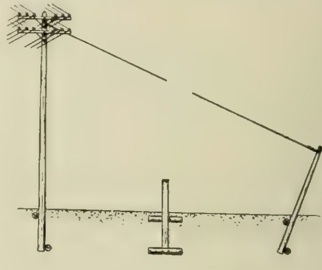


Fig. 2.—Crib Bracing.

unsightliness reduced to a minimum, so as to be unobjectionable as compared with the benefits of the electric serviee, which only their use will permit.

The problem of constructing a satisfactory overhead line is not an easy one. There are many conditions that are not altogether in the control of the line superintendent. Suitable pole locations are frequently difficult to obtain. The highway along which the line must run is generally, to some extent at least, obstructed by trees which can only be trimmed sparingly, and may also be occupied by the lines of other companies, whose construction must be taken into consideration to avoid an unsightly and dangerous tangle of poles and wires.

The back alleys of some of the smaller cities, where alley construction is in vogue, illustrate the hopeless mess which results when two or more electric light and telephone companies build their lines without reference to the lines of the other fellow. To avoid such conditions and to construct well-built lines should be the endeavor of every electric light manager whose service, in whole or in large part, is supplied by overhead construction.

The points to be considered in line construction in the order of their importance are the following:—

First and foremost, to which all others must be entirely secondary—the safety of the public and the company's employees.

Second—the reliability of the company's service.

Third—sightliness of the construction.

The question of cost has been omitted altogether, as the cost of a well-built line over that of a poorly-built line should be of no moment as compared with the much greater safety and reliability of the former construction.

These first two requirements, safety and reliability, can be considered together, the first embracing the second, for safe construction implies reliability of ser-

*Paper read before the National Electric Light Association.

vice. To meet these requirements we should use first of all, structurally sound material, of ample strength to withstand, under all conditions of service, the strains to which the line may be subjected.

The poles should not have less than 7 inch tops, should be set not less than 5 feet in the ground and be held firmly, by substantial guying against side or end pulls. The cross-arms should be of sound, honest wood, and not the sap-wood variety, which are covered with so-called red paint to hide their defects, and which are made up of the leavings of the mills after the good wood has been cut into building timber and flooring. They should be firmly bolted to the pole and should be braced.

The line wires should not be less than No. 6 B. & S. gauge in size, and they should be strung with ample clearance over highways and footways, and should be inaccessible to the general public from bridges or buildings.

The guy wires should be of stranded cable and not

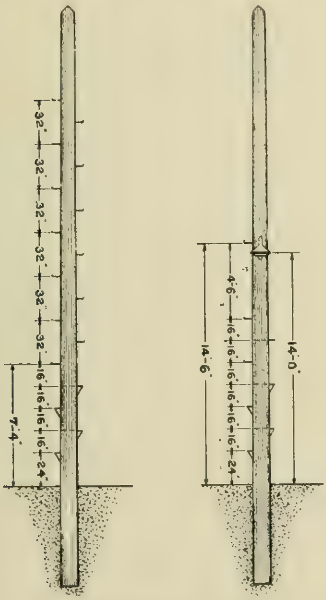


Fig. 3. Location of Pole Steps.

solid wire. They should be insulated, and, so far as possible, installed so they cannot be easily reached from the ground.

Ground wires should not be installed unless they can be connected to a permanent and effectual ground. A ground wire connected to a poor ground not only fails when it becomes charged to give the protection for which it is supposed to be installed, but becomes a positive source of danger to the passer-by.

For the safety of employees, pole wiring should be carried out in a systematic manner, so as to leave space on the pole for climbing and working. To protect the trimmer, series arc lamps should have absolute cut-outs.

Due consideration should be given to the wires of other companies in the territory. We must remember that the telephone and fire-alarm wires have much less mechanical strength than the line wires used by electric light companies, and that in case of sleet-storms they are the ones that are likely to break and come down, making possible contact with the electric light wires.

The writer does not believe in installing guard wires as a protection against such possible crosses with other wires. The stable and proper installation of such guard wires in a general distribution system is impracticable, and as they would generally have to be installed, they would increase rather than lessen the chances of trouble. When electric light, fire-alarm and telephone wires must be run in proximity, the best results to all concerned and to the public will be ob-

Fig. 4. Straight Line Guying.

tained by having the electric light wires on top and above all other wires, and when they must be run on the same side of a highway, joint occupancy of a single pole line is preferable to separate and conflicting pole lines.

Sightliness of construction will be best obtained by having the work done in a systematic manner and by using poles of a uniform height and size, set and maintained perpendicularly. The cross-arms should be of uniform length.

Wires should be pulled up with similar sag, and should not be left with any greater amount of sag than is necessary to relieve the strain due to contraction at low temperature. Systematic pole wiring, with taps for transformer connections and for branch circuits led across the pole horizontally and dropped perpendicularly, will do a great deal to help the look of things. Nothing is more unsightly than a pole with wires crossing it and leaving it in all directions and at all angles.

After the line is completed there remains the necessity of constant inspection and maintenance in order to keep it in good condition.

The above points have been enumerated in order to call attention to some of the most important items that enter into the problem of line construction. The subject is one of endless detail, and it may be of interest to quote at some length from the line specifications recently prepared for the electric companies of the

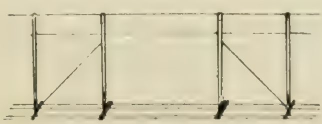


Fig. 5. Head Guying.

United Gas Improvement Company and of the Public Service Corporation of New Jersey. Omitting many paragraphs which deal with minor details, the principal sections are as follows:—

POLES.

Specification.—All poles used must be purchased under, and conform to, the company's standard specification. Round chestnut poles should be used where possible, but wooden piles other than chestnut may be used in localities where it is difficult to obtain chestnut poles. If municipal regulations require a finished

pole, yellow pine poles, in accordance with the company's specification therefor, may be installed.

Chestnut poles should be of sound, live, straight chestnut, squarred at both ends, well proportioned from butt to top, peeled, and with knots trimmed close.

The poles should be of the following dimensions:—

Length of Pole	Circumference 6 feet from Butt Not Less Than	Circumference at Top Not Less Than
30 feet	37 inches	22 inches
35 "	41 "	22 "
40 "	44 "	22 "
45 "	47 "	22 "
50 "	50 "	22 "
55 "	53 "	22 "
60 "	57 "	22 "
65 "	60 "	22 "
70 "	63 "	22 "
75 "	65 "	22 "
80 "	70 "	22 "

Sawed octagonal poles should be made of long-leaf yellow pine, sound, straight grain, and free from sapwood and unsound or large knots.

The dimensions are as follows:—

Length	Diameter at Top	Diameter at Butt
25 feet	7 inches	10 inches
30 "	7 "	10½ "
35 "	7 "	11 "
40 "	7 "	12 "
45 "	7 "	14 "

NOTE.—Diameters given are the diameters of the inscribed circle.

Poles should be finished smooth. Butts are sawed square and the tops pointed at an angle of 60 degrees.

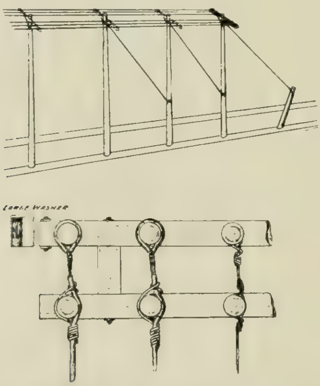


FIG. 6. METHOD OF DEAD-ENDING A LINE.

The cross-section of the finished poles, at any point, is a true octagon.

Poles are shipped unpainted, but are given one coat of boiled linseed oil before shipment.

Poles are inspected at point of delivery, and all poles not in accordance with these specifications should be rejected.

Height.—Unless taller poles are required by municipal ordinance, or by exceptional conditions, the standard height in cities or thickly settled localities should be 35 feet for poles to carry either one or two cross-arms, 40 feet for poles to carry three or four cross-arms, and 45 feet for poles to carry over four cross-arms. For lines in suburban districts 30-foot poles may be used to advantage, and their use is recommended. In general, stability of construction is sacrificed by using poles higher than necessary. The height of a pole is always considered as the total length over all.

Trimming.—Before being set, poles should be well trimmed and shaved, every effort being made to have their appearance when set as unobjectionable as possible. The top of each pole should be roofed at an angle of 45 degrees, as shown in Fig. 1.

Cross-arm Gains.—Gains for the cross-arms up to the expected carrying capacity of the line should be cut in a pole before the latter is set. Gains should be

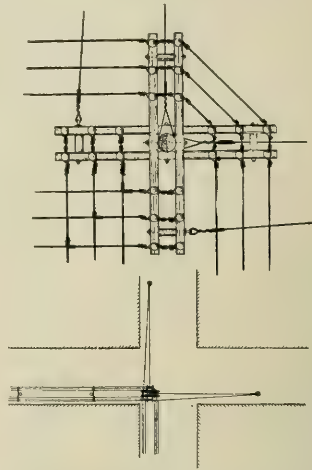


FIG. 7.—ONE-POLE METHOD OF TURNING A CORNER.

cut square with axis of pole, and with all other gains; they should be 4½ inches wide to securely fit the cross-arms, and should be ½ inch deep and spaced 24 inches apart on centres, as shown in Fig. 1. The gains for ten-pin cross-arms are 5 inches wide. The distance from the peak of the pole to the top of the upper gain is 9 inches.

Painting.—Poles that are to be painted are given a

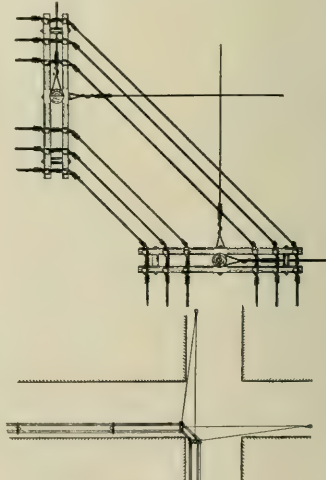


FIG. 8.—TWO-POLE METHOD OF TURNING A CORNER.

priming coat ot standard green pole paint before being taken from the yard, special attention being taken to paint thoroughly the roof, gains and parts of the pole to be set in the ground. After the pole is set, and construction line work thereon has been completed, the pole is given a second or finishing coat of standard green pole paint. Cross-arm braces, pins,

switch-boxes, wooden pole steps and other pole fixtures are painted at the same time.

Pole Numbering.—In order that complete records of the locations and number of poles in use may be kept, it is necessary that every pole belonging to the company, and every pole that is the joint property of the company and of some foreign company, be numbered and the initial letters of the company marked thereon.

Spacing.—For heavy trunk lines to carry three or more cross-arms, the spans should not exceed 110 feet. For main lines to carry two cross-arms, the spans should not exceed 125 feet. For branch lines

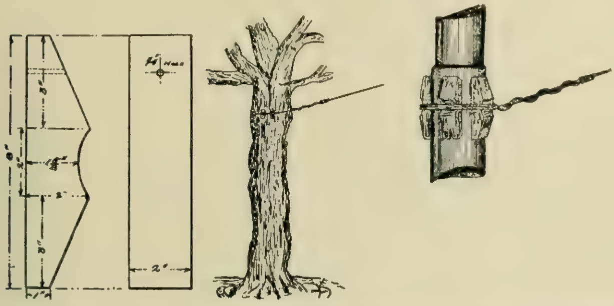


Fig. 9.—Tree Blocks for Preventing Injury to the Tree from Guy Wires.

that will never carry more than one cross-arm, the spans should not exceed 140 feet.

Street Rights of Way.—Pole lines on streets are preferable to those over private property. Where possible, poles should be located at the corners of intersecting streets. Lines should be laid out to follow one side of the street, so that the number of street crossings shall be a minimum. In laying out a new line, care should be taken to obtain an unobstructed right of way. Select the side of the street most free from trees and avoid erecting pole lines that will conflict with existing pole lines of other companies. Objection should always be made to the erection by other companies of pole lines paralleling and on the same side of the street as existing pole lines of this company.

Line Level.—The lengths of poles are so proportioned to the contour of the country, or to adjacent poles of exceptional height set to clear obstacles, that abrupt changes in the level of the wires will not occur.

Pole Setting.—Poles should be set in the ground to depths specified in Table 1. At line terminals, corners, curves, and other points of excessive strain, poles are set in the ground an additional 6 inches. They should be set to stand perpendicularly when the line is completed. Exception can be taken to this rule in that a very slight lean against the strain can be given to poles at line terminals, corners, curves, and other points of excessive strain.

Table 1.—Pole Dimensions and Settings.

Length Over All in Feet.	Minimum Cir. 6 Feet from Butt.	Minimum Cir. Top.	Depth in Ground. Straight Lines.	Depth in Ground. Curves, Corners and Points of Extra Strain.
30	37 in.	22 in.	5. ft.	6. ft.
35	41 in.	22 in.	5.5 ft.	6. ft.
40	44 in.	22 in.	6. ft.	6.5 ft.
45	47 in.	22 in.	6.5 ft.	7. ft.
50	50 in.	22 in.	6.5 ft.	7. ft.
55	53 in.	22 in.	7. ft.	7.5 ft.
60	57 in.	22 in.	7. ft.	7.5 ft.
65	60 in.	22 in.	7.5 ft.	8. ft.
70	63 in.	22 in.	7.5 ft.	8. ft.
75	66 in.	22 in.	8. ft.	8.5 ft.
80	70 in.	22 in.	8. ft.	8.5 ft.

Crib-Bracing.—Poles which cannot be strongly guyed and which must be set in soft ground, may be given additional stability by crib-bracing, as shown in Fig. 2. This consists in placing at the points of maximum strain two logs, about 5 feet long and not less than 8 inches in diameter. These furnish considerable extra bearing surface, tending to hold the pole in position. The top brace alone, or both braces, can be used according to the amount of additional stability required.

Poles to be stepped.—All poles carrying branch cut-outs, incandescent lamps or other attachments that may require frequent attention, as also all testing poles, are stepped to facilitate climbing them. For the same reason, it will be found convenient to step poles carrying transformers. The location of steps on a pole is shown in Fig. 3. They should always be placed on a line with the street on which the pole is located.

POLE GUYING.

When to Use Guys.—Guys should be used whenever they can be located so as to counteract the strain of the wires attached to a pole, and so prevent the pole from being pulled from its proper position in a line. The following general instructions cover some of the special cases where guying may be required. On straight lines carrying more than one cross-arm, poles should be head-guyed at convenient intervals, i.e., guys should extend from the top of a pole to the butts of the adjacent poles in the line on either side. If possible, this same pole should be side-guyed, i.e., guys should extend from the top of the pole on either side, at right angles to the line to guy stubs or other supports.

On street lines, side-guying can be employed only in

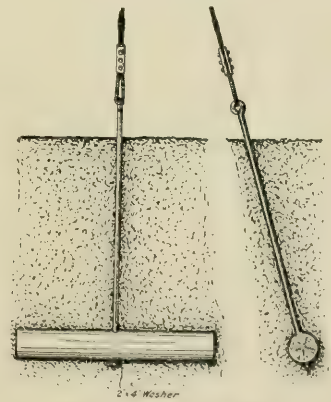


Fig. 10. An Anchor Guy.

comparatively few instances. Straight line guying is for the purpose of giving additional stability to a line in case of severe storms, and is illustrated in Fig. 4. Line terminal poles are head guyed, and on heavy lines the two poles next to the terminal poles are head-guyed to assist the latter in taking the terminal strain, as in Fig. 6.

Poles at the terminals of long spans are guyed to counteract the extra strain on the pole due to the long span, as shown in Fig. 5. In turning a corner with one pole guys are preferably placed as shown in Fig.

7. In turning a corner with two poles, guys are preferably located as shown in Fig. 8.

On curved lines carrying not more than one cross-arm, the guys are located in a line with the radius of the curve on every pole with an offset of more than 10 feet. On lines carrying more than one cross-arm, a guy is located on every pole having an offset of more than 5 feet. Poles on steep hills are head-guyed.

Guy Wire.—The material used for guying should be standard cable composed of galvanized iron or steel wire. The standard guy cable consists of seven strands of No. 12 B.W.G. galvanized iron wire. A smaller cable may be used for guying cross-arms and light poles, but no cable of less diameter than one-quarter inch should be used, nor should solid iron wire be used for guying poles or cross-arms. In connection with the stranded cable, galvanized iron guy clamps and thimbles should be used. Wrapped joints should not be made in guy wire when clamps can be employed.

Guy Attachment.—All guy wires are preferably attached to poles, guy stubs, trees or other ungrounded supports, and when so attached should not reach within 8 feet of the ground. Unless such attachment be absolutely unavoidable, guy wires should not be attached to rocks, stone foundations, iron structures or other grounded supports, and such attachments to structures are made only with the consent of the owner, and in such a manner that there is no danger of any damage to, or interference with, the free use of the structure.

On poles carrying extra-high-potential wires, guys should not be attached to the cross-arms carrying these wires, nor to the pole at or above these cross-arms. When two or more guy wires run to a pole, guy stub or other support in close proximity to each other, the attachment of one guy should never overlap that of another, but be entirely independent. In new construction work, and in rebuilding old lines, guy wires are placed and pulled to the required tension before the lines are strung.

Stub-Guying.—When a line cannot be properly guyed by means of other poles in the vicinity, guy stubs are set, as shown in Fig. 2. Guy stubs should be of sound chestnut, at least 8 inches in diameter, and of sufficient length to raise the attached guys to the proper height from the ground or from obstacles as herein specified. They are set in the ground to a depth of at least 6 feet, leaning away from the pole to be guyed, and set in the ground according to specifications applying to poles. Special stability of guy stub setting may be obtained by the use of crib-bracing, as indicated in Fig. 2, or by concrete setting.

Anchor Guys.—An anchor guy may be employed to guy poles, but must not be installed when it might interfere with surface traffic. It is constructed as shown in Fig. 10. A ¾-inch iron eye-bolt about 7 feet long is attached at the middle of, and at right angles to, a wooden anchor consisting of a cross-log of sound chestnut, not less than 8 inches in diameter, and about 5 feet long. This anchor is set in the ground so that the eye of the guy rod stands about 1 foot above the ground, the guy rod being in line with the wire attached to it. The guy rod is attached to the anchor by means of a washer and nut.

Tree-Guying.—When neither poles nor guy stubs can be obtained to which to fasten wires, conveniently located trees may sometimes be used. Guy wires should not be attached to trees without permission of the owner or other proper authorities. Tree guys are perferably attached to tree trunks. When this is impossible, attachment may be made to a live sound limb, close to the tree trunk, provided the limb is not less than 8 inches in diameter.

Tree trunks and limbs should always be protected from injury by the use of tree-blocks between the tree and the wire attached to it. Tree-blocks should be of chestnut, and should be placed around a tree trunk or limb sufficiently close together to prevent the wire from touching it. To avoid injury to the tree, guy wires should not be wrapped continuously around it, but should simply pass around the tree, supported on blocks, as shown in Fig. 9.

Clearance.—Guys should be attached to poles so as to interfere as little as possible with workmen climbing or working thereon. Every guy which passes either over or under any electric wires other than those attached to the guyed pole should be so placed and maintained as to provide a clearance of not less than 24 inches between the guy and such electric wires, under all conditions of temperature and sag. As changes in temperature will affect the sag of the wires more than that of the guy, the latter being under strain, allowance must be made for this at the time the guy is installed.

Guy Insulation.—All guy wires attached to poles carrying electric light or power wires should be insulated by the insertion of at least one strain insulator. In the case of head guys and side guys, the insulator is located at the upper end of the guy, and at least six feet from the pole, measured horizontally. Where any portion of the guy passes under electric light or power wires, other than those attached to the guyed pole, a second strain insulator is used, placed 6 feet from the lower end of the guy.

Guy wires which are attached to a non-insulating support, such as a rock, iron pole, bridge, or any other structure, and anchor guys, should have inserted in them two strain insulators, one being so placed as to protect a man working on the pole from coming in contact with that portion of the guy beyond the insulator, and the other placed so as to be out of reach from the ground or structure.

[To be continued.]

ELECTRIC HOISTS.

As builders of both electrical apparatus and hoisting engines, Allis-Chalmera-Bullock, Limited, Montreal, are able to supply a complete electric hoist. Both motors and engines are constructed and tested in their own shops and under the immediate supervision of the engineers who designed them and who are familiar with the conditions necessary for their successful operation as one unit.

They recently sold the Dominion Coal Company a hoisting engine to operate two water buckets each capable of holding 800 imperial gallons to a depth of 345 feet. The hoist will be driven by one of their 300 h p. induction motors. The contract also included three 125 k.w. transformers.

The Bell Telephone Company will remodel their system in Galt, Ont , next year by the installation of the central energy.

The progressiveness and far-sightedness of the citizens of Saskatoon is greatly exemplified in the amount of electric light wiring that is being done in that town. The town already boasts two electrical construction and supply firms and about three dozen new buildings wired throughout, though as yet an electric lighting plant has not been even definitely decided upon by the town council. But it is sure to come, and within a year at most.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Question No. 1.—Can you give me any cause for incandescent lamps jumping in a house here last week during an electric storm? I had a bad burn-out, a goose-neck bracket in a bedroom completely melted. The owner told me that this lamp flickered and flashed a lot. Other lamps in his house did the same but not so much. This is a three-wire two-circuit system, divided in the house at a panel cut-out. Why should this house give trouble in this way and others not? In my own house I never throw my switches in a storm, and have no trouble. In another house during an electric storm, while the engines were shut down at the power house, a fuse was blown. This house was partly wired some years back, and I added to it a few months ago. This same light on which the fuse was blown (without any current on at power house) gave trouble in the same way. Can you give me any reason for this?

Answer.—Such phenomena as you mention, and which are due to lightning, are very difficult to explain, and a lack of parallel cases makes it still harder to draw definite conclusions. We would think from your question that, due to a lightning discharge, a current was induced on the power wires, passing from one of the outside wires to the neutral and thence to ground. This would cause the flickering of the lamps, and might easily result in the burning out of the goose-neck bracket. It would also account for the blowing of the fuse in the other house mentioned, and as the source of the disturbance is lightning, the fact that the power house was disconnected would probably have no effect, unless in disconnecting the power house the lightning arresters were also cut out of service, under which circumstances the manifestation would be more marked. Why one house should give trouble and others be immune, it is impossible to say without a personal examination, and even then, such examination might throw no light on the question. We may say that as a general rule it is a difficult matter to explain lightning phenomena.

Question No. 2.—Where telephone wires on power poles give trouble from induction, would it be possible to run such wires underground? Does the earth act as a shield under such conditions?

Answer.—While the telephone line in connection with a power transmission line would certainly be run underground, and all inductive effects eliminated, still this practice would be unnecessarily expensive, considering that satisfactory results can undoubtedly be obtained when the telephone wires are mounted on the power wire poles. The proper transposing and insulating of the telephone circuit should make the trouble due to induction practically nil, and we do not know of any line in operation to-day where it has been found necessary to put wires underground. If, however, the wires should be run underground, a two conductor cable would undoubtedly be used, and hence there would be no inductive effect. The burying of the wires underground would to a very great extent eliminate all inductive troubles, even though an untwisted cable were used, but, as you are doubtless aware, all telephone cables made to-day are practically non-inductive. It has been suggested that twin conductor wire be used overhead for telephone circuits liable to be affected by alternating current lines. This has been tried with complete success, so far as induction troubles are concerned, but the great difficulty experienced has been that persons with shotguns have, either maliciously or otherwise, fired at the wires, and lead pellets cutting in between the conductors have made complete short circuits. For this reason the twin conductor wire has been abandoned for overhead except in cities, etc.

Question No. 3.—Can you give me the composition of the "electrolyte" used in storage batteries?

Answer.—Electrolyte is a simple mixture of pure sulphuric acid and distilled water. Normally the acid has a specific gravity of about 1.8, in other words it weighs about 1 4/5 times the amount of water. The acid is diluted with distilled water until the specific gravity of the mixture is approximately 1.2. Various makers of storage batteries specify different specific gravities for the electrolyte to be used in their cells, and this information can always be obtained on application to the manufacturers. The specific gravity is in every case measured by means of a hydrometer, and the reading is taken with the electrolyte at a specified temperature, usually 60 degrees Fahrenheit. In mixing up electrolyte, the acid must always be poured into the water, never the water into the acid. When the mixture is made, considerable heat is generated, and the electrolyte must never be put into the cells until the temperature drops to normal. If you are figuring on making electrolyte yourself for storage battery use, we would advise you to obtain from the maker of such storage battery information covering the strength of electrolyte to be used, and also the method by which the batteries are to be charged when the new electrolyte is poured into the cells.

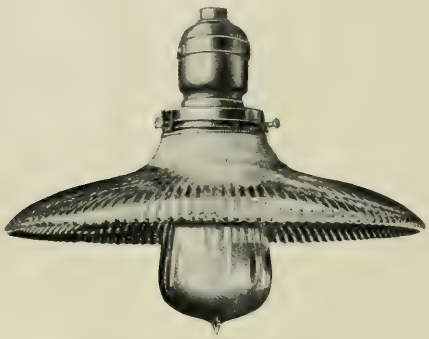
Question No. 4.—What is the Standardization Committee so often referred to in connection with electrical guarantees?

Answer.—The American Institute of Electrical Engineers appreciated some years ago the fact that it was necessary to standardize various tests and ratings applicable to electrical apparatus, and a committee known as the Standardization Committee was formed to investigate this matter and report on same. The Committee reported in 1899, and a supplementary report was brought forward and presented at the nineteeth annual convention which was held at Great Barrington, Mass., on June 20th, 1902. The report of the committee has been adopted practically all over the United States and the requirements are invariably acknowledged by first class manufacturers of electrical apparatus. The report itself is very complete, and gives very full information covering tests of all kinds. Generally speaking, the report is divided into ten departments, as follows: Efficiency, rise in temperature, insulation, regulation, variation and pulsation, rating, classification of voltages and frequencies, overload capacities, luminous sources, appendices.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

General Electric Tantalum Incandescent Lamps.—The latest improvement in the electric incandescent lamp field is the now comparatively well-known tanalum lamp, which has a filament composed of the rare metal tantalum capable of withstanding very high temperature and giving a very brilliant white light. This lamp is now being produced at the General Electric Company's lamp works at Harrison, N. J., and is offered by it as a lamp giving the highest efficiency of any form of commercial incandescent lamp available today.

The saving in the cost of the lighting to the customer puts a large premium upon higher efficiency lamps, and the latest production of invention and research is really notable in results obtained. The General Electric tantalum lamp gives an actual efficiency of two watts per candle, based on the mean horizontal English parliamentary standard, with an average useful life on direct-current circuits of 700 hours or more.



GENERAL ELECTRIC TANTALUM LAMP.

The construction and general appearance of the new lamp are clearly shown in the accompanying illustration. When used with the special holophane pagoda reflectors provided with the lamps, the downward lighting efficiency is increased to one watt per candle or better. Two forms of reflectors are provided, the distributing form, which gives a characteristic meridian distribution, and the concentrating form, which gives a more centralized distribution beneath the lamp.

The lamp is at present supplied by the General Electric Company in but one size, having a consumption of 44 watts and giving a mean horizontal rating of 22 candlepower. It is made for voltages of 100 to 130 volts, and fitted only with standard Edison base. It is not recommended for use on alternating-current circuits.

This lamp will enable central stations to reduce the cost of lighting to the customer, and therefore meet and resist competition, secure additional desirable business and increase its net earnings. While the first cost of the tantalum lamp is somewhat higher than that of the ordinary carbon-filament lamp, this additional cost is saved several times over by the consumer buying light at average meter rates given by electric-lighting companies.

The average life of the lamps is about 750 hours and the value of the tantalum lamps, as shown by the saving they secure in consumers' cost of lighting at various rates per kilowatt-hour, is given by the manufacturer in the accompanying table.

	Saving in Cost of Current at Various Rates of 22 Candle Power, 44-watt G. E. Tantalum Lamps.	
Rate per K.W. Hour Cents.	Over Present 3.5 W.P C. 22 C. P. Lamp.	Over Present 3.1 W.P C. 25 C. P Lamp.
10	$2.47	$1.80
11	2.83	1.98
12	2.97	2.15
13	3.24	2.33
14	3.47	2.51
15	3.72	2.69

It is expected the new lamp will be supplied to lighting customers on direct-current circuits on a liberal policy as to charges, either on a renewal or on a purchase basis. The lamp possesses several attractive features which will appeal both to the central-station man and to his customer. The advertising value of this new lamp as a novelty represents an asset to the lighting company first introducing it to the public in its section.

On an equal pro-rated useful-life basis with present 16-candle power 3.1 watts per candle power lamps, central stations now supplying free renewals of 16-candle power 3.1 watts per candle power lamps could afford to supply tantalum lamps at a low figure without adding to their present lamp renewal costs. Central stations now furnishing free renewals of 3.5 watts per candle power lamps, could similarly supply the tantalum at a little higher figure without increasing their renewal costs. In any case the consumer, as shown by the foregoing table, would save several times the value of the charges of the tantalum lamp.

Incandescent Electric Lamp with Refractory Blower.—A somewhat unusual form of incandescent electric lamp was recently patented by Herschel C. Parker of New York city, the inventor having in mind a cheap and simple, but at the same time durable, lamp in which the light-giving body is a pencil of a refractory non-conducting substance with which is mixed a small percentage of conducting material. The pencil thus formed will allow the passage of current when cold, and will be heated to incandescence upon continued passage of the current.

It was found by experiments that by mingling some refractory non-conductive substance, such as thorium oxide or carborundum, with a small percentage of a refractory conductor, such as graphite, and shaping the mass into a pencil, the latter being preferably compressed, a current could be passed through the pencil when the latter is cold. The substance would have sufficient resistance, however, to cause the pencil to be raised to a high heat, and thus provide an efficient lamp.

It is probable that other substances than the thorium oxide and carborundum may be used, but the substances

must be of such a nature that when mixed with the conductor they will produce a light-giving pencil and not one which will merely glow under the influence of the current.

The Telegraphone.—A series of interesting tests of the telegraphone were made during last month in the neighborhood of Winnipeg and were most successful. The great advantage of this instrument is that it makes it possible to use a dispatcher's wire, which is in constant use in the carriage of telegraph messages, for telephone purposes at the same time. The telephone has also many obvious advantages over the telegraph, and while the telegraph is valuable for certain purposes, the possibility of being able to use the telephone without the construction of new lines of wire appears exceedingly attractive to railway men. One of the tests was made on the Canada Northern Railway between Winnipeg and Emerson. The train was run out to a distance of six miles from the city and the connection made with the telegraph wire. Winnipeg was called up and all the C. N. R. officials spoke through the instrument. Emerson was then called, the second test being quite as successful as the first. The Canadian company handling the telegraphone has its head office in Montreal, J. W. Fisher, of Montreal, being president ; Dr. Matthewson, of Ottawa, vice-president ; F. C. Hirsch, of Montreal, secretary-treasurer, and Messrs. Hanley and Bartholomew, of Montreal, directors.

The Beck Flaming Arc Lamp.—The Beck flaming arc lamp is one of the latest developments in arc lamp construction, and aside from its value as to light economy, it possesses additional advantages of merit. One of the troubles met with in flaming arc lamps has been due to the fact that the vapors from the carbon would get into the mechanism; and where this mechanism is complicated, considerable trouble results. Mr. Heinrich Beck, of Meiningen, Germany, has worked out this new principle of carbon feed, the simplicity of which is very striking. The principle of the feed is that the carbon, which has a rib running its entire length, rests on a metallic shoe. This rib burns to a fine point. The point gradually disintegrates and crumbles, and allows the positive carbon to sink slowly by gravity; and as the negative carbon is connected by a compensating chain, it feeds downwards at the same time. The positive carbon is of greater diameter than the negative carbon, so as to allow the electrodes to burn evenly.

The Wright Demand Indicator.—The Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass., have recently placed on the market a special portable outfit for the use of the Wright demand indicator in outdoor work. The outfit includes a weather-proof housing and insulating board fitted with hangers to be attached to the cross-arm of the pole beside or near the transformer. Mounted at the bottom of the board is a "Wood" arc circuit cutout, which serves to shunt the Wright indicator and to disconnect it from the circuit without interrupting the latter. The attaching plug is permanently connected to the indicator leads, so that the entire equipment is self-contained and may be removed intact. To test a transformer it is only necessary to install the equipment on the cross-arm and substitute the attaching plug for one of the fuse plugs from the primary fuse box. As the Wright demand indicator records the maximum current which has passed through it any time since it was last set, it may be read at any desired period after being connected—an hour, a day, a week, or a month— and will show with absolute precision the maximum load which the transformer has had to carry since it was connected. The instrument may be connected in the secondary circuit instead of the primary, if desired, in which case the arc cutout, which is interposed merely for safety in reading and resetting, becomes unnecessary.

MONTREAL LIGHT, HEAT AND POWER COMPANY.

The fifth report of the Montreal Light, Heat & Power Company, for the last fiscal year makes a remarkably fine showing, both the gross and net earnings showing a large increase over the previous year. The gross earnings for the year, amounted to $3,186,102.74, as against $2,901,264.67 for the previous year, or an increase of $284,838.07. The net profits, after providing for fixed charges, interest, etc., amounted to $1,278,486.31, against $1,128,789.05 for the previous year, or an increase of $149,697.26.

The report states that the two new fireproof distributing stations referred to in the last annual report have been completed during the year. The fireproofing of the company's power house at Chambly has also been completed. It is the purpose of the directors to continue the work of fireproofing the remaining electric stations, which will not only reduce the liability of fire hazard, but will result in a considerable reduction in insurance rates.

Owing to the largely increased demand for power, it has been decided to develop during the present season the surplus water of the Soulanges canal, the rights to which the company acquired through the purchase of the Provincial Light, Heat, and Power Company. The power plant, when completed, will have an output of approximately 15,000 horse power, and will place the company in an excellent position to supply all demands made upon it for power.

The increase in the company's business continues to be most satisfactory, the following additions having been made during the year:

ELECTRIC DEPARTMENT.

Incandescent lamps connected	30,448
Commercial arc lamps connected	112
Street lamps connected	180
Power connected	6,636 H.P.

GAS DEPARTMENT.

Meters installed	5,110
Stoves, generators, etc., sold	2,563
New services put in	1,775 or 11.3 miles
New mains laid	12.2 miles

To afford its customers better conveniences and to facilitate the handling of the company's business, the directors acquired the very centrally located site at the northwest corner of Craig and St. Urbain streets, upon which it is proposed to erect a commodious office building. This will fill a much-needed want, as the present offices have proved totally inadequate to handle the largely increased business.

The Grand Manan Telephone Company, Grand Manan, N. B., desire to increase their capital stock to $7,000.

The Canadian National Exhibition, Toronto

The progress that has been made by the Toronto Exhibition during late years is probably unparalleled by any other similar enterprise. Always a good Exhibition, it has grown under the present management to magnificent proportions. Among the many improvements which have been brought about, the number of new buildings is perhaps the most prominent feature. On entering the grounds one cannot but make comparison with the unpretentious and inartistic buildings in which the exhibits were housed some years ago.

The Exhibition which has just closed was almost perfection in most respects. The exhibits were more numerous, more attractive and more instructive. In the new Process Building were to be seen many demonstrations of manufacturing processes from which much could be learned.

The Machinery and Electrical Hall was crowded with exhibits and a larger building will soon be a necessity. This building was particularly attractive owing to the large number of colored electric lights. The extent to which electricity was used throughout the buildings and grounds is shown by the fact that 600 arcs and the equivalent of 3,000 16 c.p. incandescents were connected up, and in addition a large amount of electric power was used for the operation of motors. Mr. G. C. Mooring, as superintendent of light and power, had direct charge of the Machinery Hall and Process Building.

The exhibitors of electrical machinery were this year confined to four firms. The Jones & Moore Electric Company, of Toronto, occupied a large space in the centre of the building, in which they showed a number of bipolar and multipolar dynamos of moderate size and a wider range of motors, also a complete switchboard, Adams-Bagnall arc lamps and a full line of electrical supplies, fans, telephones, etc.

The T. & H. Electric Company, of Hamilton, had their usual neat exhibit of dynamos, motors, switchboard instruments, etc., and the Consolidated Electric Company, of Toronto, showed their "King Edward" dynamos, several motors, and a line of supplies.

The Electrical Construction Company, of London, Ont., had on exhibit a 30 k. w. generator, which was driven by a 35 h. p. rotary engine of the Tree pattern manufactured by the Manson Manufacturing Company, of Thorold, Ont. This engine is very compact and occupies little room, and is also claimed to be economical in steam. It has no valves or valve gear, and the expansion of the steam is controlled by the number of wings and the offset given to the drum or rotor. The oil is automatically pumped on the wings, and is thrown from them by centrifugal force on the other internal moving parts, thus insuring perfect lubrication. The Manson Manufacturing Company are prepared to supply the engine for direct connection to generators, in sizes from 5 to 150 h. p., and in speeds from 400 to 1,200 r. p. m.

The growing use of gas and gasoline for power purposes is demonstrated by the large number of exhibitors of these engines. The display of the Economical Power, Light and Heat Company, of Toronto, in the Process Building, attracted a great deal of attention. It consisted chiefly of a 40 h. p. Pintsch suction gas producer supplying gas for a 20 h. p. National gas engine belted to an electric generator in operation. The company intend to manufacture the Pintsch gas producer and the National engine in Canada and are looking forward to a large business.

A gas producer plant was also exhibited by the Producer Gas Company, of Toronto, consisting of a 35 h. p. Campbell gas engine and a 35 h. p. Campbell suction gas plant. The engine operated with very little vibration, and the suction gas plant consumed but 300 pounds of coal in ten hours.

Gas and gasoline engines were exhibited by Goold, Shapley & Muir, Brantford; Smart-Turner Machine Company, Hamilton; Toronto Junction Gasoline Engine Company, Toronto Junction; Canadian Fairbanks Company, Toronto and Montreal; Labatt Manufacturing Company, London, Ont.; Defiance Iron Works Company, Chatham, Ont., and several other companies who make a specialty of marine engines.

Two "Johnston" oil engines of 15 h. p. were exhibited in operation by the Johnston Oil Engine Company, of Toronto. The claim made for this engine is that it will furnish power for ten hours a day at a cost for fuel of less than $11 per horse-power per year.

The largest exhibitor in the Machinery Hall was the Canada Foundry Company, of Toronto, who occupied a space 120 x 14 feet on the south side of the building. Here they showed a wide range of products manufactured by the company, including "Northey" pumps, ore crushers, steel forgings, special castings, waterworks supplies, "Easy" injectors and a water tube boiler. The exhibit, which was displayed in a very attractive manner, was in charge of Mr. H. O Edwards.

The more universal use of the telephone has opened up a wider field for the manufacturers of such apparatus. Among the United States firms who have recently established branches in Canada is the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., and Chicago, Ill. This company exhibited in the Machinery Hall their telephones and telephone apparatus, aerial and underground lead-covered cables, etc. Their Canadian office is in the Canada Permanent Building, 18 Toronto street, Toronto, Mr. James S. Gibson being in charge. They claim to be the largest manufacturers of telephone apparatus in the world.

The Swedish-American Telephone Company of Chicago, also had a nice exhibit of serial exchange telephones, bridging telephones for party or rural lines, selective signaling telephones and switchboard equipment. This company have equipped several independent exchanges in the United States, and are now giving considerable attention to the Canadian field.

The Century Telephone Construction Company, 59 Adelaide street west, Toronto, also a new concern, exhibited telephone apparatus in the Process building, while the Citophone Company, of Toronto, was another exhibitor. The citophone enables any person to change an ordinary bell circuit into a telephone installation and is specially adapted for factories, offices, hotels hospitals, etc. It consists of a transmitter and receiver

mounted on opposite ends of a black insulated handle.

The James Morrison Brass Manufacturing Company and McDonald & Wilson, both of Toronto, each had a splendid display of artistic electric, gas and combination fixtures, while the Morrison Company also exhibited the Nethery valves, steam gauges, injectors and a varied line of brass goods.

The Dodge Manufacturing Company, of Toronto, occupied their usual space in the Machinery Hall with a creditable exhibit of Dodge wood split pulleys, shafting, clutches, couplings, rope drives, etc. The exhibit of rope drive extended from one side of the exhibit to the other and showed the means of keeping a constant tension on the rope. Adjoining their exhibit was that of the Babcock & Wilcox Company, which consisted of a large water tube boiler equipped with the B. & W. superheater.

Roller bearings were exhibited by the Chapman Double Ball Bearing Company, of Toronto, and Canadian Bearings, Limited, of Hamilton. The former demonstrated the power saving qualities of their bearings by means ot a coal car laden with coal and weighing in all over three tons, which could be moved by the light pressure of one hand.

The exhibit of the Canada Metal Company, Toronto, consisted of babbitt metals, battery zincs, fuse wire, solder, pig lead, antimony, lead pipe, and traps and bends, a line of goods for which they have become well known.

J. N. Tallman & Sons, of Hamilton, had a neatly arranged exhibit of their "Arctic" babbitt metal, pig lead, antimony, Tallman's white bearing metal, etc., Mr. J. F. Birchard being in charge.

An exhibit which interested steam users was the automatic boiler cleaner shown by Mr. Joseph Carter, of Blyth, Ont. Mr. Carter is the patentee of this device, which he claims is very efficient in removing sediment and scale from boilers.

The Canadian Oil Company, Toronto, exhibited their Sterling oils and varnishes in an artistic manner in the Manufacturers' Building, where was also to be found an exhibit of Spooner's copperine.

There were but two exhibitors of belting, namely, D. K. McLaren, Montreal, and the Dominion Belting Company, Hamilton, but the goods displayed proved their ability to manufacture belting for all requirements.

SOME THINGS TO AVOID IN CONSTRUCTION WORK.

The subjoined list of defects found to exist in the electrical equipment of various towns and cities in the West by the Underwriters' Electrical Bureau may prove of interest to contractors and other electricians. It is not intended as a "counsel of perfection," but points out possible weaknesses which should be carefully watched.

1. Wires too near roof.
2. Wires not properly insulated from cornice, awning frames, etc.
3. Service wires not properly installed and insulated.
4. Wires undersized.
5. Circuit or line wires overloaded.
6. Wires not properly bushed through floors, walls or partitions.
7. Wires not protected from mechanical injury
8. Wires not properly installed in elevator shaft.
9. Wires do not have sufficient support.
10. Wires supported by wooden cleats, staples, etc.
11. Wires not properly bushed at outlets.
12. Wires do not have approved insulated covering.
13. Wires crossed or are in contact with gas or waterpipe.
14. Lamp cord used in show windows.
15. Use of unapproved lamp cord.
16. Lamp cord used for circuit wires or excess lengths of cord.
17. Lamp cord used to support clusters.
18. Lamp cord subjected to moisture or corrosive vapors.
19. Pendant wires not supported independently of line wires.
20 Joints and splices not properly soldered and taped.
21. Signal-service wires not properly installed and bushed.
22. No protective device for signal wires.
23. Signal wires not properly installed.
24. No service cut-out.
25. Use of open cut-outs.
26. Cut-out not properly protected against mechanical injury.
27. Change in size of wires without fusible protection.
58. Use of canopy cut-out in fixtures.
29. Outside cut-out not properly protected against the weather.
30. Cut-out cabinet unlined.
31. No service switch.
32. No service switch for series arc lighting.
33. Knife switches not properly installed.
34. Flush switches not provided with iron or steel boxes.
35. Snap switches not provided with a sub-base.
36. Outside switch not properly protected against the weather.
37. Fixtures wired with unapproved wire.
38. No insulating joint for combination fixtures.
39. Wood hanger boards.
40. No spark arrester for arc lamp.
41. Incandescent lamps too near inflammable materials.
42. Unlined or broken sockets.
43. Use of metal sockets in damp places.
44. Sockets not properly protected from inflammable gases.
45. Sockets not provided with bushings.
46. Wooden, broken or unapproved rosettes.
47. Use of fused rosettes in places containing dust or gases.
48. Use of untreated or improperly constructed molding.
49. Molding used in damp places.
50. Molding not properly installed on walls.
51. Transformer in or on building.
52. Wood rheostat.
53. Rheostat not properly protected from combustible materials.
54. Unlined snap switch.
55. Uninsulated fixture canopy.
56. No magnetic release for rheostat.

The firm of Lemery & Cathcart, electrical contractors, has recently opened up new offices and show rooms on 21st street Saskatoon.

TELEGRAPH and TELEPHONE

INDEPENDENT TELEPHONE CONVENTION.

The first annual convention of the Canadian Independent Telephone Association was held in the City Hall, Toronto, on Wednesday, September 5th. Mr. A. Hoover, of Green River, Ont., presided, and a considerable number of persons were present representing independent companies and the telephone supply firms. Addresses were delivered by Mayor Coatsworth, of Toronto, Hon. Colin Campbell, of Winnipeg, Mr. F. Dagger, of Toronto, Mr. A. B. Hoge, president of the International Independent Telephone Association, Cleveland, Ohio, and others.

The report of the Secretary, Mr. A. F. Wilson, contained the following statistics regarding telephone companies.

Number of absolutely independent or non-Bell companies or private systems	73
Number of shareholders	3,248
Number of subscribers, Aug. 15, 1905	6,427
Number of snbscribers, Aug. 15, 1906	12 073
Increase in one year	5,646
Capital invested	$850,000

The above does not include the Central Telephone Companies of New Brunswick.

The annual report of the Bell Company of Canada shows that on December 31, 1905, it had 78,195 subscribers, and an increase in 1905 of 12,035.

Most of the speeches were in the direction of urging legislation against the Bell Telephone Company. A resolution was carried that inter-communication between local systems and long distance business should be secured exclusively over or by means of trunk lines operated by independent companies or owned by the province. Another resolution was adopted urging that the legislature be petitioned to rescind all legislation which permitted the municipalities to grant exclusive franchises to telephone companies.

The Association will interview the chief authorities of the various railway companies and arrange, if possible, some fair and reasonable basis for terms in connection with access to and the placing of the instruments of independent companies in railway and other depots, the crossing of telephone lines over railroads, and the use of railroad bridges and other communications so that all telephone companies shall be placed on an equal footing.

The following officers were elected: President, Alph. Hoover, Green River, Ont.; vice-president, F. D. MacKay, Toronto; secretary-treasurer, A.F. Wilson, Markham, Ont.; executive committee, T. F. Demers, M.D., Levis, Que.; W. Doan, M. D., Harrietsville, Ont.; C. J. Thornton, Kirby, Ont.; Dr. Ochs, Hespeler, Ont.; Richard Vigars, Port Arthur, Ont.; E. Hart, M. D., Brantford, Ont.; Levi Moyer, Beamsville, Ont.; F. Dagger, Toronto; C. Skinner, Sherbrooke.

Among the interested gentlemen present, including manufacturers' representatives, were: W. H. Lytle, Canadian Machine Telephone Co., Toronto; Dr. A. C. Beatty, Garden Hill; S. B. Purdy, North Gwillimbury and Sutton Co-Operative Telephone Co., Keswick; A. W. Venning, J. Daws, Belmont Telephone Association; C. B. Adams, Harrietsville Telephone Co.; P. H. Fox, Northport; D. D. Yack, North Dorchester; J. J. Salmond, Canadian Engineer; St. George Lamoine, Beauceville, Que.; F. A. Dales, Stouffille and Bethesda Telephone Co., Stouffille, Ont.; G. W. Jones, Clarke-Hope Phone Line, Port Hope; J. H. Doane, CANADIAN ELECTRICAL NEWS, Toronto; J.G. Sprague, Sprague Telephone Co., Demorestville, Ont.; E. Barrowclough, Clarke-Hope Phone Co., Port Hope; W. B. Dickinson, E. J. Dickinson, Port Hope; R. Y. Ellis, Stark Phone, Light and Power Co., Toronto; Geo. B. Wright, York State Telephone Co., Binghampton, N. Y.; Col. A. E. Belcher, Southampton; E. Hart, American Machine Telephone Co., Bradford; T. D. MacKay, Canadian Machine Telephone Co., Toronto; J. C. Keenan, Keystone Engineering Co., Toronto; C. W. Davidson, J. Brody; Mount Albert; Dr. A. Ochs, Hespeler; Thos. Patterson, Kendall, B. G. Hubbel, Consolidated Telephone Co., Buffalo; J. Lockie Wilson, Alexandria; J. E. Hyatt, Prince Edward; George L. Wilson, Toronto; C. G. Strange, Barrie; Alex. Neilson, Brown's Corners; G. W. Whipprent, Sound Waves, Chicago; H. Bragg, Canadian Municipal Journal, Montreal; Ald. J. J. Graham, Toronto; H. B. McMeal, "Telephony," Chicago; A. E. Reesor, Markham-Pickering Telephone Co., Locust Hill; E.B. Overshiner, Swedish-American Telephone Co., Chicago; F. W. Pardee, Chicago; J. A. Wentworth, Chicago; H.A. Nutall, Century Telephone Construction Co., Toronto; Frank T. Hodgins, Toronto; F. J. Donnerque, Kellogg Co., Chicago; H.C. Randall, Geo. W. Brown, Chicago Telephone Supply Co., Elkhart, Ind.; J. C. Kelsey, Kellog Co., Chicago; R. Hendrickson, North Electric Co., Cleveland; G. R. Rudormer, Muskegon; A. C. Clay, Northern Electric Manufacturing Co., Montreal; J. A. Fletcher, Pringle Co., Toronto and Montreal; Evah Shelby, Sterling Electric Co., Layfatte, Ind.; W. E. Campbell, Swedish-American Manufacturing Co., Chicago; J. S. Gibson, Rochester, N. Y.

SHORT-CIRCUITS.

The ratepayers of Edmonton, Alta., recently carried a by-law to raise $65,000 to install a new telephone system.

Mr. C. Y. Schwab, who has been assistant manager of the Bell Telephone Company at Guelph, has been appointed local manager at Walkerton.

The Bell Telephone Company have completed an additional long distance metallic line from Hamilton to St. Catharines, which will, in the near future, be extended through to Buffalo.

The Nova Scotia Telephone Company have decided to make a number of improvements in the Eastern Telephone Company's system lately purchased by them. Among these will be the erection of a new exchange at North Sydney.

The Ontario Government has granted a charter to the Niagara District Telephone Company, with a capital of $10,000 and head office at Jordan, Ont. The provisional directors include C. Wismer, Alonzo Culp and Alexander Troup, all of the Township of Louth.

The Ingersoll Telephone Company, Limited, Ingersoll, Ont., has been incorporated, with a capital of $50,000, to operate a telephone system in the counties of Lincoln and Wentworth. Messrs. Charles Miller, H. F. Boyce, E. H. Hugill, and others, of Ingersoll, are directors.

It is understood that the Bell Telephone Company are considering the building of a fifth exchange in Montreal, to be situated in the north end of the city. The erection of a new exchange in Toronto, to accommodate the northwest section of the city, is also said to be on the tapis.

The Central Telephone Company has been absorbed by the New Brunswick Telephone Company, and as a result the telephone war on the North Shore is at an end. By the purchase of the Central Company's rights the New Brunswick Company have acquired a number of valuable exchanges, and they will now be enabled to give the public a more satisfactory service

WIND POWER APPLIED TO ELECTRICITY.*

By Prof. Dahl, of King's College.

From time to time we hear from the daily and the technical press about the enormous amount of power that we let go to waste by not utilizing the force of the wind for other purposes than the propulsion of vessels, and even that at an ever decreasing rate.

Of course we know quite well that we have coal enough to supply the demand of the world for many years to come, but after that what is to happen to the human race. Ought not we to begin to look around for a power to supplant that derived from the coal. When Niagara has been fully harnessed, and the Victoria Falls utilized to its last drop, it will still only be a very small part of the world's supply.

It is evident that we must turn to the power placed at our disposal by nature, the water and the wind.

I shall shortly review what has been done till now to place the unsteady and varying wind power at our disposal in the ideal form of electricity.

The greatest argument against the use of the wind for power purposes is that it is so unreliable and often apt to fail when it is mostly wanted.

But this is greatly exaggerated in most instances, as the statistics show, as well as the experience with the ordinary windmills.

It depends of course on the location, but when it is anywhere near the sea, protracted calms lasting more than 12 hours are nearly entirely absent.

It would be of no interest to give data from any particular locality because they would only apply there, and people might, as many are so apt to do, use the figures for other localities, because, as some of you will know, it is no mean piece of work to compile reliable statistics for so variable a quantity as the wind velocity.

It ought to be compiled for as great a number of years as is obtainable, and of course the worst case in the statistics ought to be provided for.

The real reason why we do not use to a far greater extent this source of power, is the failure of science to develop the machinery used along correct lines. I should be surprised if anybody present here has ever seen an exhaustive treatise on the construction of windmills treating it along the same rational lines as we treat the design of steam engines.

The present designs have been arrived at through experience and failure and we have to be cautious when we apply them to a new purpose, as for instance to generate electricity.

I shall say a few words about the proper design of windmills because before we can expect efficient plants we must know what to specify.

We have two distinct classes of windmills, namely, the four-winged and the multi-winged mills. For electrical purposes we may disregard the multi-winged mill altogether, as it is in no way suited for such purpose. The four-winged mill gives a fairly high speed, so that the gear losses are small. It is very efficient due to a vacuum formed behind the wings, an advantage entirely destroyed with a large number of wings. Lastly, a four-winged mill is simpler and much cheaper than a multi-winged windmill.

Turning to the electrical part of the system, it is evident that we must have some kind of a storage for the electricity that the supply may always be equal to the demand. This of course at once cuts off the use of alternating current. Several methods of storage are at the present time being developed, but at the same time the only successful one has been by means of an accumulator battery.

From the windmill the power is transmitted by shafting to a cratostat. This serves to regulate the power, so that no overload can be thrown on the dynamo during stormy weather. It is generally simply an arrangement of slipping belts, the slipping being in proportion to the overload. The dynamo is driven directly from the cratostat.

*Paper read at the Summer Convention of the Maritime Electrical Association, Sydney, N. S.

From the dynamo the current passes to an automatic switch which closes the charging circuit when the electro-motive force of the dynamo is greater than that of the battery, and breaks the circuit when the dynamo slows down during calms.

The battery is always connected across the main cables, so that when the dynamo is running at full load it feeds the lamps and charges the battery in parallel.

Thus the plant is entirely automatic in action and all the attendance that is required is the occasional examination of the lubrication and the inspection of the accumulator battery.

With regard to the proportions of the machines and accumulator, a great deal depends on the location. The relative size of the windmill and the dynamo is determined by the average wind velocity in the locality.

The size of the battery is of course determined by the length of the calms and the consumption of current at the time of the calms. All this is determined much in the same way as the available power from a water supply.

There is a limitation for the size of a windmill, because while the cost of material increases with the third power of the linear dimensions, the power only increases with the square of the linear dimensions of the wings' surface. Hence we arrive at a size where it would be cheaper to build two small mills instead of one large one. This occurs at a wing diameter of about seventy-five feet. Such a mill could be counted upon to give an average of about 30 horse power, which is generally far in excess of what is required for isolated plants, but what represents just what is often required in a village for light and power.

We must of course generally have a reserve in the shape of an oil engine to carry us over protracted calms and this increases the first cost, but it is not very often we have recourse to it. The oil-engine need not be of the same power as the windmill, because during a calm it can work at full load all day charging the battery. I shall shortly describe two typical plants that have been working most successfully for several years. The first one has been running since 1902. The only disadvantage was a rather small battery which owing to local conditions could not be enlarged.

The windmill has four wings of 72 feet diameter and 8 feet wide. It supplies a village with light and a small amount of power, the installations amounting to 460 incandescent lamps, two arc lamps and two small motors. The total yearly supply is about 5,000 kilowatt-hours, and this represents at 12 cents per kilowatt hour, $600.

The running expenses were :

Oil for reserve engine	$ 75
Attendance	100
Lubrication, etc.	25
Total	$200

The capital account is $4,250. Deducting 5 per cent of this, corresponding to a depreciation of about 7 per cent., we get a net profit of 4½ per cent.

I have had a wide experience with small isolated plants on large farms in Denmark, and I have always found that a farmer or a farm hand chosen with a little judgment, after a little careful instruction, makes an excellent engine attendant for oil engines and dynamos as well as batteries. He is more reliable than many a mechanic, feels his responsibility a great deal more and takes great pride in keeping everything spick and span to show off to his admiring fellow citizens. These advantages coupled with smaller wages by far outweigh the disadvantage of his limited knowledge of mechanics.

In the present case the oil engine was used fourteen times during the year and the observations show that if the battery instead of being able to supply the demand for forty-eight hours as at present, had been able to supply it for seventy-two hours, the oil engine would only have been used three times instead of fourteen.

4½ per cent. is not a great dividend on invested capital, but the plant was not running at anything like its maximum capacity, also I would like to meet the man who would care for supplying current at twelve cents a unit from a plant with thirty horsepower as its maximum output and still pay 4½ per cent. in dividend. Neither must we underrate the value of this plant to the inhabitants of the village by the increase in industry and trade.

If the plant had been driven by an oil engine alone without any windmill, the result would, roughly speaking, at best have been a deficit of 2 per cent. of a capital of $3,000.

The second plant is one erected on a farm of moderate size. The windmill here has also four wings, thirty-six feet in diameter and six and a half feet in width.

It gives as an average five horsepower, and supplies light and power to the farm.

The threshing machine when running takes three horse power; besides this it pumps the water, drives the churn, and other dairy machines, the cake crusher and chaff cutter. The reserve here is a horse mill but it is very seldom resorted to. The capital account is just $1000 and therefore the depreciation is $50 a year.

The revenue is difficult to estimate exactly, as are also the running expenses. But if we estimate the time used looking after the machinery to be worth $50, we have an expenditure of $100 and with lubrication and incidentals say $150.

As revenue we must reckon the saving of $70 for hire of threshing engine with machinist for six days. A more important saving is that of labor. On a small farm it is easy to do with one hand less and this will be a still greater saving on larger farms.

The amount saved in this case may moderately be set to $100, and thus we have already $20 to our credit, having reduced all expenses.

The greatest and most encouraging feature of this is the opening it gives for improved handicraft. I have not seen sufficient of this country to give any opinion about the agricultural state of it, but I have learnt that the farmers are thrifty and, when they have the chance, progressive. Such a plant as I have last spoken of gives the farmer the advantage of the use of electric light by nights. During the long dark winter nights, he may apply himself and his rising family, as we do in my old country, to handicrafts of every description or to the improvement of the mind by reading.

At home the peasant women still spin their homespun to supply the whole family and what is left over commands a fair price in town. Now, one person can with ease attend two machine-driven looms with six times the output of a hand-driven one and this is just one example of the great opening the electric power offers the farmer. At the first plant I described, they went even further than this, by starting the manufacture of what I wou'd call bye-products. As mentioned before, the plant was not working at anything like its full capacity. Well the remaining power was used for the electrolysis of water into oxygen and hydrogen. These were put on the market, compressed in steel cylinders and found great favor with manufacturers. This process is, however, still in an experimental stage, but promises a rich future for this new field for electricity.

And with regard to the future prospects of the wind electricity?

Well! Do you not see before you a future dreamland with windmills dotted all over it, spanned by a network of wires, all the mills feeding the same net and the farmers ploughing, reaping, threshing and irrigating by electricity, using the power of nature under the control of men?

I hope by this short paper to have drawn attention to a branch of electrical engineering that has been greatly neglected and still offers great opportunities.

PROFESSOR HERDT'S OBSERVATIONS.

The reputation of McGill University, particularly for its Practical Science course, is filling all England. Everywhere you go you hear about McGill, and its representative men who are world famous, Professor Rutherford, Nicholson, and Callender. Young men, after taking a course in scientific education in some English technical school, are now coming out to complete their course in McGill, which has an equipment for Applied Science scarcely equalled in England, France, Belgium or Switzerland.

These are some of the enthusiastic expressions of opinion given by Professor Herdt, who returned to Montreal on August 31st, from England, where he attended the meeting of electrical engineers arranged by the British Institution.

According to Professor Herdt, three countries have a a great electrical future before them, Canada, the United States, and Switzerland, all of which are abundantly endowed with water power. One experiment being tried at Zurich, Switzerland, is of peculiar interest to Canada. That is the testing of a single phase electric locomotive. These tests will probably result in the permanent use of this locomotive as the electric locomotive system of the state. Canada with its increasing use of electric traction would probably, in the view of Professor Herdt, find this system the best for its necessities in its constant development in electrical enterprises.

Prof. Herdt was accompanied to Europe by his wife and little son.

ALCOHOL MAY SUPPLANT GASOLINE.

Winthrop E. Scarrett, former president of the Automobile Club of America, addressing the members at the recent annual meeting, said that the decreasing supply of gasoline was a subject of vital interest to motorists.

"There are in use in America approximately 70,000 motor cars," said Mr. Scarritt. "These do not consume as much as the 800,000 gasoline stoves which are in use all over the Middle West, where fuel is always high. During the past five years the price of gasoline has doubled. The California and Texas oils are practically barren of gasoline distillates, and while the supply of gasoline is not growing, its consumpton is rapidly increasing. What is our remedy for this threatening situation? It lies in the direction of vegetable alcohol. At present the United States Government taxes all alcohol $2.00 per gallon. There is no reason why this tax should not be removed on denaturized alcohol; that is, alcohol renderd unfit for drinking. Experiments with this fuel made in France, and also in America, by Prof. Elihu Thompson, show that it may be used as a motor fuel successfully. Germany last year used over 70,000,000 gallons of denaturized vegetable alcohol.

"Its general use in this country would furnish a market for the farmer's surplus corn, apples, beets, potatoes, etc. A bushel of corn will make two and a half gallons of alcohol. The surplus of this year's crop over the average corn crop would produce 700,000,000 gallons of alcohol that would be sold at a profit at the present price of gasoline."

Among recent sales by the electrical department of Allis-Chalmers-Bullock, Limited, Montreal were a 260 k.w. engine type, alternating current generator, with exciter, switchboard, etc., to the Western General Electric Company, Red Deer, Alta.; 300 k.w. engine type, alternating current generator, with exciter and other acccessories, to the corporation of Barrie, Ont; 300 k.w. engine type alternating current generator and 25 k.w. exciter to the Belleville Portland Cement Company; 125 k.w. engine type alternating current generator, exciter, etc., for the city of Greenwood waterworks; 63½ k.w. engine type alternating current generator, switchboard, etc., to C. P. Walker, Winnipeg, and 125 k.w. engine type alternating current generator, five 10 h.p., three 15 h.p. and one 20 h.p. induction motors to P. Burns & Company, Calgary.

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THE PLANT OF THE HALIFAX ELECTRIC TRAMWAY COMPANY*

By Philip A. Freeman, Chief Engineer.

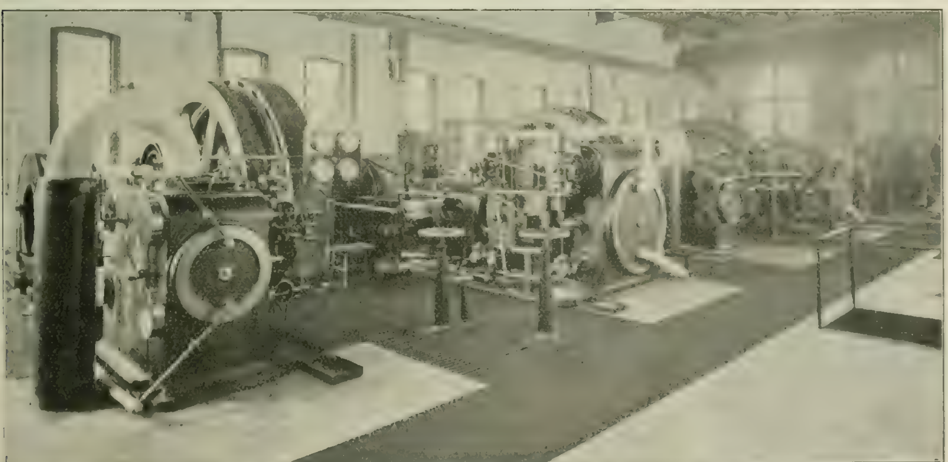
The subject of this paper covers such a broad field that I finally decided to confine my paper to certain limits, avoiding all intricate formulæ and deductions, although both are necessary for the competent engineer.

At times it is somewhat difficult for an engineer to decide upon the type of boiler to use, and in every case the choice should depend upon the nature of the work demanded whether it is better to use water tube, externally or internally fired, etc. Many plants are able to use with good economy a return tubular boiler, and the selection of a water tube boiler would be of no advantage in comparison with the increased first cost. For railroad work, and for that where the demand for steam is liable to increase rapidly during certain hours of the day, the water tube boiler is by far the best. With a first-class water tube boiler, a fireman can carry for a certain length of time from 50 per cent. to 100 per cent. above the rating of the boiler.

In our plant at the Tramway station we have seven 250 H.P. Babcock & Wilcox boilers. (One horse power equals 30 lbs. water evaporated per hour from 100 deg. Fah. into steam at 100 lbs. pressure, or 34½ lbs. water evaporated per hour from and at 212 deg. Fah.)

Four of the B. & W. boilers were purchased in 1902 and 1903 for our new plant, and each of the four has also connected to it a B. & W. patent superheater containing about 330 sq. ft., making a total heating surface of 3,150 sq. ft., and making a total horse power for each of the four of 280 H.P.

The other three boilers were used in our old plant previous to the invention of this type of superheater. Boiler pressure carried averages 150 lbs.; temperature saturated equals 370.28 + 100 deg. superheat, or a total temperature equal to 470.28 deg. Fah. Saturated steam at 500 lbs. pressure equals only 466.57 deg. Fah. You readily understand that before any condensation takes place at the cylinders the steam must lose all its superheat, and losses from condensation range all the way from three to 20 per cent.



Halifax Electric Tramway—View of Engine Room, Showing Three Rice & Sargent Engines.

We have also installed for our boilers fourteen Jones Underfeed stokers. In February, 1899, we installed two Jones Underfeed stokers, and in November, 1899, eight American Worm stokers. We installed the American for its automatic feed attachment. In 1901 we replaced the eight American stokers with eight of the Jones, and in 1904 ordered four new Jones stokers to complete our new plant, making fourteen Jones stokers in the plant. In one year's actual operation with stokers against hand firing in our old plant we showed an actual saving under same operating conditions in engine room of 11 per cent. Since install-

*Paper read at the annual meeting of the Mining Society of Nova Scotia.

ing the automatic feed attachment for operating stokers we show an increased saving of 10 per cent. over feeding stokers by hand. With hand fired boilers we rebricked boiler walls four times each year; with stokers, about every nine months. The cost for parts of stokers per year is about one-half what it costs for grate bars under hand fired.

We use a Foster regulator on our steam main to fan engines that regulates the steam pressure within 5 lbs. Also from shaft of air fan we operate our stoker feed attachment. When steam drops, Foster regulator admits more steam to blower engine. When steam rises to 150 lbs. the regulator cuts off steam and admits less air and coal to furnace.

We have installed two outside packed plunger feed pumps 4" suction and 3" discharge. We take the feed water from a Cochrane open heater at a temperature from 210 to 212 deg. Fah. possible. The exhausts from our feed pumps, stokers, and drips from our car house and office heating systems also discharge into open heater. The open heater receives its supply of water through a regulating valve from induction heaters on each of the main engine exhaust piping. The average degree in temperature received from the induction heaters equals 90 deg. Fah. above city water temperature. We are connected to two 6" city water mains.

ENGINE ROOM.—We have installed three Rice & Sargent engines, 18" x 36" x 32" x 150 revolutions per minute, made by the Providence Engineering Co., Providence, Rhode Island. Rated capacity, 900 I. H. P. Style of engines, horizontal, cross compound, condensing, direct connected. Duties or guarantee:

Steam consumption at 450 H. P.	....	13 9-10 lbs. steam
" " " 675 "	....	12 8-10 "
" " " 900 "	....	13 25-100 "

Horse power at 150 lbs. steam, 28 per cent; cut-off, 900 H. P.; at maximum cut-off, corresponding indicated horse power, 1350. Friction of unit, no load, at 150 rev., 61 H. P.

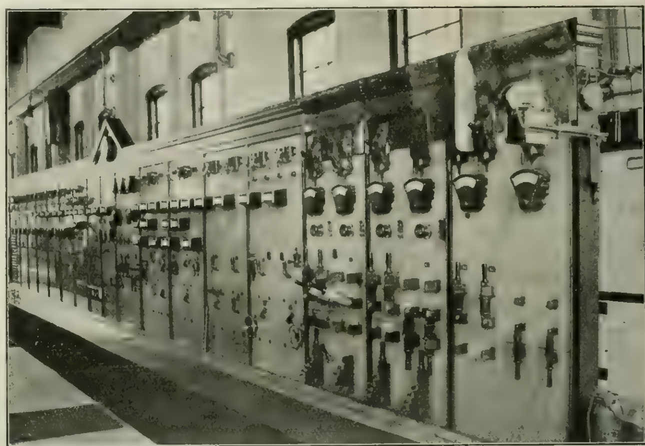
GENERATORS.—On engine shafts, one C. G. E. alternating generator; type A. T. B. Class 48 fields, kilowatts 600; rev. 150; amps. 158, good for 50 per cent. overload for one hour.

RAILROAD EQUIPMENT.—Three induction motors. Motor end: Type 1, Class 11.; H. P., 330; 514 rev.; cycles, 60.; volts, 2200; amps. 85; speed 514. Direct current end: Type M. P.; Class 6 fields; horse power 225; rev. 514; Form A.; volts, no load, 325; full load, 575; amps. 391. Also one synchronous set used for motor circuit, elevators, etc. Motor end: C. G. E. Co. make, voltage 2300; kilowatts, 300; speed, 600. Coupled to a direct current generator. Sold by Walker Co. Made over by cutting off ⅓ of its base, and shortening and placing a coupling on its shaft. This direct current armature is operated as a belted unit to a 13" x 24" x 24" x 150 rev. per minute. Robb engine, 1896 to 1902.

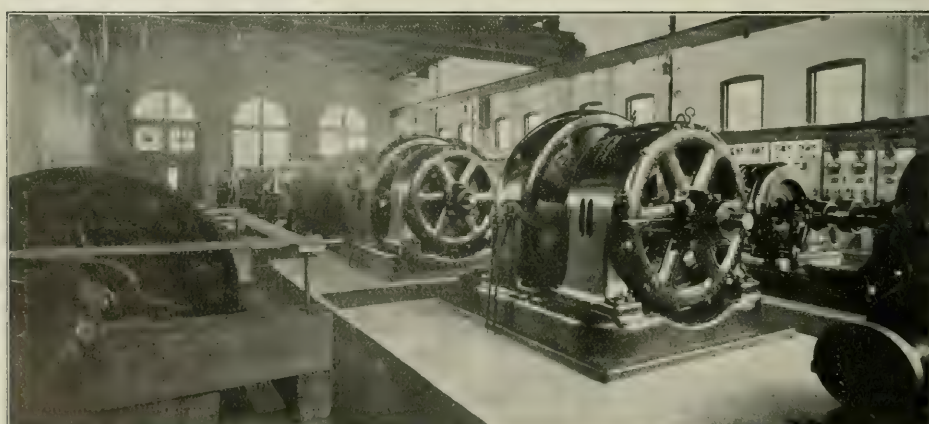
Two exciter induction sets, C. G. E. Co. make.

One direct connected steam driven exciter set, C. G. E. make.

Engine made by Robb Engineering Co., Amherst.



HALFIAX ELECTRIC TRAMWAY—VIEW OF SWITCHBOARD.



HALIFAX ELECTRIC TRAMWAY—THREE INDUCTION MOTORS FOR TRAMWAY, SYNCHRONOUS MOTOR GENERATOR SET FOR POWER CIRCUITS, ETC.

Four type R., Form A., 100 light series arc oil transformers, primary voltage, 2200, secondary voltage 75, amperes 7.5., for street arc lighting, cycles 60.

Also one 50 series arc oil transformer, same as above. We use the latter for commercial arc lighting, 6.5 amps. and 75 volts.

OILING SYSTEM.—We use one receiving tank, one

HALIFAX ELECTRIC TRAMWAY—VIEW OF BOILER ROOM, CONTAINING SEVEN BABCOCK & WILCOX BOILERS EQUIPPED WITH JONES STOKERS.

200 gallon capacity Cross oil filter, and to house hot water tanks. We use the latter as pressure tanks.

METHOD OF OPERATING.—All dirty oil and water flows into receiving tank from engine room floor. Also mechanically arranged that on this basis, as water and oil weigh 1-9 less per measure than water, and by placing a drip water pipe 4″ from bottom of receiving tank, and piping it up to 8″ from top of tank, then place an overflow oil pipe 6″ from top of tank, the oil overflows to the Cross oil filter and the water goes to the sewer. On the bottom of the pressure tanks we have connected a city water pipe that gives about 35 lbs. pressure on our oiling system. The method used to take oil from Cross oil filter or oil barrel into pressure tank is: We have connected to each engine a vertical jet-condenser, from condensers a 1″ pipe main to pressure tanks. To operate we close the city water supply, open valve on filter or barrel, open the valve to condenser. The vacuum takes water out of tank and the oil takes the place of the water at no cost for power. Each tank has a water gauge glass.

Kilowatts generated per imperial gallon engine and cylinder oils, 1902, 1903, 1904 and 1905 :

OILS USED.

1902.		1903.		1904.		1905.	
Eng.	Cyl.	Eng.	Cyl.	Eng.	Cyl.	Eng.	Cyl.
2247	1024	1140	676	686	622	413	570

TOTAL KILOWATTS.

1902.	1903.	1904.	1905.
4,908,432	5,393,248	6,008,290	6,084,600

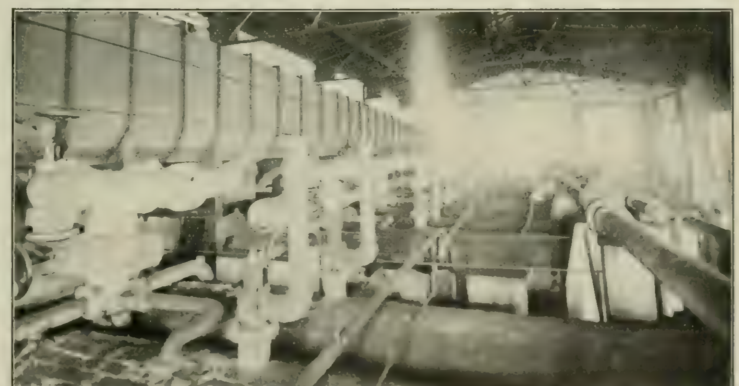
KILOWATTS PER IMPERIAL GALLON.

	1902.	1903.	1904.	1905.
Eng.	2184.44	4750.1	8758.32	14490
Cyl.	4793.3	7977.02	9659.75	10674

We have on engine room floor two oily waste presses made of 12″ pine, about 24″ long, with 1¾″ screw, five threads to the inch, the lever 12″ long from its centre. In the old plant we had to press waste by hand to extract the oil. We saved the waste for two months after extracting the oil by hand. Then we placed it in the press. The press saved one barrel of oil. Previous to purchasing the waste press we used five lbs. waste per day. Since then only one lb. per day.

OPERATING AND CARE OF BOILERS.—In these days of keen competition it is absolutely necessary to take every precaution for reducing operating expenses, of which the coal pile represents a large pecentage. At the Tramway plant it represents 62.5 per cent. at the bus-bar. The best of boilers will not take care of themselves, and will generate steam according to the manner in which they are treated. Shovelling coal into the furnace and keeping a sufficient supply of water in a boiler does not constitute the entire duties of a fireman. He must shovel coal and feed water to the boiler intelligently, and study the peculiarities of the steaming preperties of his boilers and coal. I might add that no two boilers of the same make, with exactly the same handling, will give the same results.

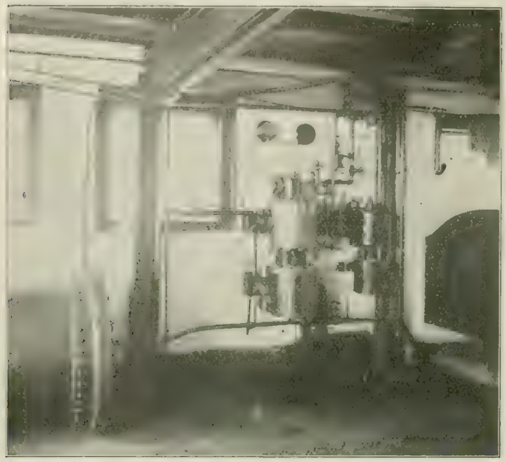
The proper maintenance of boiler demands that they should be shut down and examined inside and out thoroughly at least every nine weeks. At the Tram Company we shut down every five weeks. The boiler should be thoroughly blown out and cleaned, even if



HALIFAX ELECTRIC TRAMWAY VIEW SHOWING METHOD OF PIPING, SUPERHEATER AND SATURATED STEAM PIPE CONNECTIONS.

solvents are to be used for the prevention of scale. In our plant we use the following method for preventing scale and for cleaning the boilers : The feed is supplied to the boilers through the 6″ city water mains to the induction heater, then to the Cochrane open heater. This has already been described. When the boiler is taken off the line for cleaning and general overhauling, we pump it full of water in which about

20 lbs. of sal-soda have been dissolved, while it is still under pressure and the boiler stop valve closed. It is then allowed to remain 48 hours, by this which time the steam pressure has fallen. The blow-off is opened and the boiler emptied. It would seem at first that this would be sufficient to thoroughly clean the boiler, but it is not so. If the feed water valve is slightly opened and the water allowed to flow slowly through the boiler, it will then be thoroughly cleaned, as this slow filtration through the boiler seems to bring with it all the dirt, scale, etc., which was not carried away by blowing down. Also particular care should be taken that the feed valves of the other boilers are closed during the time we are filling the boiler with the sal-soda solution. Otherwise brass engine fittings, etc., will be seriously affected.


HALIFAX ELECTRIC TRAMWAY — WESTINGHOUSE AIR PUMPS USED FOR VOLTAGE REGULATION AND CLEANING PURPOSES.

Safety valves are most delicate parts of the boiler and demand constant care and watching, if we wish them to work fairly accurately. My experience with spring safety valves has led me to adopt the rule that safety valves shall be partially lifted from off their seats, once at least, every 24 hours. If this is not done, I find that a so-called skin forms on spring and seat, and if the valve is not lifted oftener than once a week, it will take considerably more pressure to lift it than for which it was originally set. Another very serious trouble with safety valves, which often occurs, is the loosening of the checknut, and if this is not attended to immediately upon the indication of such trouble, the steam pressure will drop and all steam escape into the atmosphere, shutting down the plant. Although it at first appears difficult to the engineer or fireman to tighten the nut and set the valve properly, nevertheless, if he understands his type of valve thoroughly, he can accomplish it with his monkey wrench, hammer and chisel in a very short space of time with perfect safety to himself and plant. If the valve should commence to blow off and steam pressure drop more than 5 lbs., or if the steam pressure should at any time drop more than proper on account of the safety valve blowing off, the engineer or fireman should at once assume that the valve is out of order, and must be attended to immediately. If check nut is loose, it can be remedied by turning the valve spindle to the right until the steam stops escaping. Then the cap may be removed and the check nut tightened without further difficulty. The boiler pressure should be increased to the same point at which the valve blew off and beyond in order to make certain that the valve will blow off at the proper pressure. This point can be easily obtained by slightly turning the valve in the proper direction.

The above method of handling the safety valve is that commonly used in ordinary practice, but for close regulation the cushion seat should also be raised or lowered according to the range within which it is desired to have the safety valve act. Under no conditions should the safety valve spindle or any of its parts be struck or hammered in order to make it close, at this is a very dangerous practice and is liable to cause more or less serious explosions. This latter precaution of mine may seem to be hardly necessary, yet, in my own experience, I have seen an engineer strike down on the spindle with a piece of 6 x 6 wood with the idea of causing the valve to close. Although at this time of which I speak no serious results occurred, it might have caused great danger the very next time it was tried.

My experience has led me to believe that boiler explosions are caused by careless and unintelligent attention to the supply of water and not at all times through inherent defects in the boiler. The gauge cocks should be tried regularly in order to detect any false indications of water in the glass. False indication of water is not by any means an uncommon occurrence. The sudden breaking of a gauge glass causes the valves of the column to be closed, and on replacing the glass, the bottom valve is opened and the upper


HALIFAX ELECTRIC TRAMWAY VIEW OF OIL SYSTEM.

one forgotten. The glass, under such conditions, will show false water, as the water will remain in the glass until the boiler is emptied, held in position by the vacuum in the top of glass. This very case has occurred in our own plant, but any dangerous results were averted by prompt action. In connection with this I recall an answer given by a chief engineer in the West End power house, Boston, to the Board of Examiners. He was asked what he would do if, on entering a boiler room, he discovered no indication of water in his boiler. He said he would make sure the water was shut off, close all drafts and open his furnace door. On being asked what he would do next, he replied that he would leave the building and watch it from a safe distance.

Pumps are usually given the least care, worked the hardest of the equipment, and at the same time play the most important part in a station. They should be given the same careful attention as the steam engine. We make it a practice to completely overhaul our

Halifax Electric Tramway—Exterior View of Power House.

pumps once a week, in order to detect any faults that may exist or are liable to occur. Special care should be paid to the water plunger and valves. Valves should be used which are made to withstand the temperature of the water which passes through them. Disregard of this may cause serious trouble. In our plant we use brass valves in feed water pump. We use jet condensers, which give an increased economy of 20 per cent. Surface condensers should not be used if possible, on account of the deteriorating effect of the oil upon the tubes of the boilers. And if the water is not to be used again in the boilers, then there is no gain, but a loss in installing surface condensers, on account of increased first cost and increased cost in running. Heaters and condensers demand the same careful attention as pumps.

Engines.—The selection of an engine demands the same careful consideration as boilers, whether high or low pressure ; single or cmpound ; high or low speed ; steam jacketed, etc. ; for heavy and variable loads, the compound engine is generally accepted. Large, low speed, compound engines with wide expansion are generally accepted as more efficient than single cylinder engines. This is clearly shown by the results of tests on the compound engine. When this engine was run as a single engine it used 24 lbs. steam per 1 h. p., and when run as a compound engine with the same load steam pressure, and under the same general conditions, it only used 20 lbs. of steam per h.p., thus demonstrating that the compound engine was 30 per cent. more efficient than the single engine. Especially are compound engines more efficient with high steam pressures.

Engines for street railroad work, and other work imposing sudden changes of load and unusually heavy strains, should be built with heavy forged cranks, and wheels of about double the usual weight, and with all parts in such proportions as will give perfect work under the most trying conditions. Governors for this work must be especially good and must respond to sudden changes of load, and to continue to regulate closely under all circumstances. The variable cut-off on low pressure cylinder is also a strong point in such engines for this work, as it ensures quick work, quick regulation, and high economy. Under variable loads, the regulation of our Corliss engines is within 3 per cent., giving the greatest satisfaction, and up to the present time three of this type of engine have been in constant use on our total output, railroading and lighting, since September, 1902, when our first Corliss unit started. November, January and February we have to run our three engines every evening except Sunday. Each engine runs 30 hours alternate, and the day load varies from ¼ load to 50 per cent. overload on account of the variable railroad load.

An engine should be indicated every three months on account of the wear and tear of the parts, and the variation in the valve rod connections. In our old plant our engines were first set by hand, and then by the use of the indicator, a saving of 19 per cent. was shown.

On taking charge of our old plant September, 1895, the boilers were carrying nearly their capacity. By indicating the engines and setting valves properly we were able to increase our engine load 50 per cent., and only increased our boiler load 10 per cent. All this simply goes to show that the indicator should be used freely and intelligently in order to effect the greatest economy.

The profitable use of steam jackets is a much discussed question, and many engineers disagree. My experience with nine 1000 H.P. engines, steam cylinder and head jacketed, has led me to doubt the advisability of using the steam jacket on the cylinder barrel. I advise jacketing the cylinder heads. In my opinion the extra cost of maintaining the extra steam piping and the liability of damage to the cylinders more than counterbalance the saving obtained by steam jacketing the barrel of cylinder. If an engine cylinder has cooled down, the greatest care must be taken in re-heating the cylinder through the use of the steam jacket, or else a cracked cylinder will result, on account of the unequal expansion. Such an accident has occurred under my own observation, and it has not made me very enthusiastic to use steam jackets on barrel of cylinders, but I strongly advise steam jacketing the cylinder heads.

The switchboard at the Tram plant I have not men-

tioned. It is one of the safest and best equipped in the country, and has to be seen to be admired.

ADDENDUM.

[In a letter to the Electrical News Mr. Freeman says: "You will please find enclosed under separate cover photographs for illustrating the Halifax Electric Tramway Company's plant. In the paper I read before the Maritime Mining Society I did not mention that this company also operated the gas plant in Halifax.

"A particular part of the plant to which I did not refer was the floorof the engine room. The photos from basement show concrete ceiling, and, of course, the ceiling of basement and floor of engine room are one. The concrete floor is made of 4" concrete expansion metal laid as usual; concrete made of best Portland cement, 1; ashes, 5; clean sharp sand, 2. Used 575.3 square yards of expansion metal.

"We have a perfect engine room floor, used the trowel good and hard. Finished concreting floor spring of 1904, and there is no dust from it. The floor is in good condition to-day. To lay the concrete floor and operate the plant same time with all the wiring from all machines up to switchboard through the concrete without stopping the plant was a problem to solve.

"The length of the switchboard is 57 feet; the total number of wires from basement to switchboard through concrete flooring, 122; number of wires through flooring from induction exciter sets and starting compensators, 29. We solved the problem by using single ply tar paper on top of the temporary wood centering boards flush with top of eye-beams, then placed the expansion metal on tar paper. Only one wire showed fire from the water from concrete. The boarding used was part of an old building we had to remove.

"The floor is painted every year. Standard expansion metal used, 3" x 8" mesh. This plant is the most up-to-date in Canada of its capacity.

"During the erection of the plant Mr. M. G. Starrett was consulting engineer, Mr. F. A. Huntress general manager, and Mr. C. B. Graves assistant manager. The present manager is Mr. J. W. Crosby, and the chief engineer Mr. P. A. Freeman."—The Editor.]

POWER HOUSE EQUIPMENT.

The Montreal Light, Heat & Power Company have recently contracted with the Canadian Westinghouse Company for a large addition to their power equipment. The apparatus contracted for is for their new Soulanges canal power station on the St. Lawrence river. The equipment consists of three Westinghouse 3750 k.w. revolving field alternating current, two bearing generators connected to water turbines. These generators are 7200 alternations, 4,000 volts, three phase, operating at 225 revolutions per minute. There are also two Westinghouse 150 k. w. direct current 125 volt exciter units. Westinghouse 2500 k.w. oil-insulated, water-cooled transformers to the number of thirteen are an important part of the equipment. Seven of these transformers will be used for raising the voltage at their generating station from 4,000 to 44,000 volts, and six of them will be used at the lowering end of the transmission line, stepping down the voltage from 44,000 to 12,000.

The generators and exciters will be controlled by motor-operated rheostats, and the complete switchboard apparatus, which the Canadian Westinghouse Company are furnishing for both the main and substations, will involve the latest type of electrical control, representing the highest development of switchboard apparatus.

CHIEF ENGINEER P. W. SOTHMAN.

Mr. P. W. Sothman, late consulting engineer of New York City, who has been appointed chief engineer of the Hydro-Electric Power Commission of Ontario, began his new duties on September 1. Mr. Sothman is a native of Denmark, and though only 36 years of age, he has been constructing and managing engineer for various waterpower and steam developments in Germany, Russia and South Africa, for Siemens & Halske Electrical Manufacturing Company, and manager and chief engineer for the large distributing company of Strassburg, Germany, for seven years ending 1905, since when he has been consulting engineer in New York City. He comes with the highest testimonials from all companies with which he has been connected. He graduated at the Institute of Technology at Charlottenburg, Germany, in 1891.

Mr. P. W. Sothman,
Chief Engineer Hydro-Electric Power Commission of Ontario.

Mr. Sothman's duties as chief engineer of the Hydro-Electric Power Commission will be to do estimating, constructing and managing on behalf of such municipalities as may apply to the Power Commission for power under the act.

There were about 100 applicants for the position. The salary that is to be paid to Mr. Sothman has not been made public, but it is understood it is fairly commensurate with his attainments and experience.

The Ontario Power Company, which operates on the Canadian side of Niagara Falls, recently decided upon the enlargement of its power house capacity and contracted with the Westinghouse Company for two of the largest power generators ever manufactured. These machines are of 10,000 h. p each and are called water-wheel generators. The Power Company has already installed four machines of a similar type, which were also furnished by the Westinghouse people. This last contract includes switchboard appliances.

Line Construction for Overhead Light and Power Service

By Paul Spencer.

(Continued from September Issue.)

CROSS-ARMS

Specification.—All cross-arms used must be purchased under and conform to the company's standard specifications. The dimensions adopted by any company will depend somewhat on the character of the service and the surrounding conditions, and should be uniformly adhered to. The following specification covers the purchase of cross-arms, and the dimensions for two different classes are shown in Figs. 11 and 12.

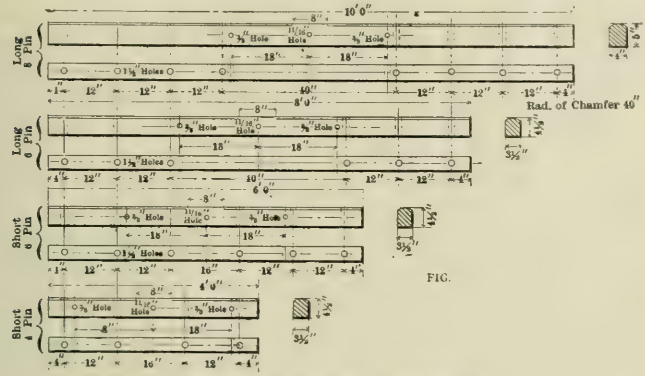


Fig. 11. Dimensions for Cross-Arms.

Cross-arms shall be made from sound, straight grain, long-leaf yellow pine, free from sap wood, shakes and unsound knots.

The dimensions shall be as shown in Figs. 11 and 12. All cross-arms shall be sawed true and square, and the centres of holes shall be on the centre lines of the arms.

Cross-arms shall not be painted, but as soon as cut and finished shall be stored so as to be protected from the weather until shipped. No kiln drying or other artificial methods of seasoning shall be used.

Cross-arms shall be subject to inspection at points of delivery, and all arms not conforming to the requirements of this specification shall be rejected.

Painting.—Cross-arms should be kept under cover until seasoned, and then painted with two coats of standard green white-lead paint before being placed on poles.

Fitting Cross-Arm to Pole.—When possible, cross-arms should be fastened to a pole before the latter is set. Before being placed on a pole, each cross-arm is fitted with two braces, attached to the cross-arm by carriage bolts. When the cross-arm is placed in position, with the braces facing away from the pole, an eleven-sixteenth-inch hole is bored through the centre of the gain, and a five-eighths-inch cross-arm bolt driven through the cross-arm and pole.

This cross-arm bolt is of just sufficient length to pass completely through the pole and cross-arm and receive its complement of washers and nuts. One square washer is placed under the head and one under the nut at the end of the bolt. The back of the pole should never be cut out to allow the use of a shorter bolt, and projecting bolt ends should not be left on.

Cross-arms should invariably be placed either at right angles or parallel to the line of the street on which pole is set, and they should always be faced on the opposite side of the pole from that in which the maximum strain comes. On straight lines where the spans between poles are equal, the cross-arms are faced alternately on succeeding poles, in first one direction and then the other, as shown in Fig. 4.

Double Arms.—At line terminals, corners, curves and other places where there is excessive strain on the cross-arms, pins and insulators, the pole is double-armed, as shown in Figs. 6 or 13. Where wires cross from one side of the street to the other, the two crossing poles are double-armed, the arms being at right angles to the line of the street. The cross-arms on poles adjacent to crossing poles should face toward the crossing.

At line terminals, the last pole is double-armed and the cross-arms of the last two poles before the terminal pole faced toward the latter. In turning corners with two poles, the corner pole is double armed, as shown in Fig. 8. In turning corners on one pole, double-arming may be used, as shown in Fig. 7, if the reverse arms do not cut down the space between the nearest wires and the cross-arms so as to make it difficult for the men to climb through. Where on corner poles the use of double arms would reduce the clear space to less than twenty inches, the double-arming should be omitted and the line held by double-arming on the adjacent poles to the corner pole, as in Fig. 14. If

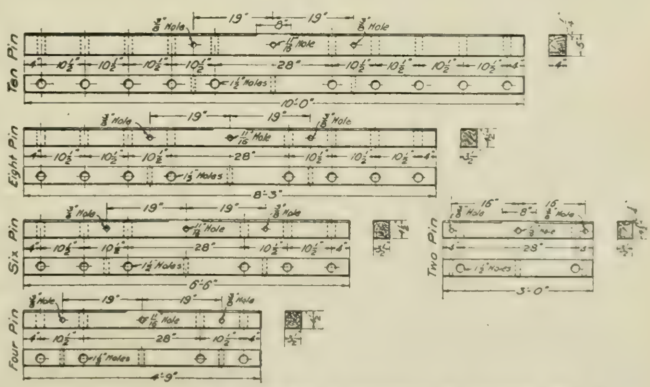


Fig. 12. Dimensions of Cross-Arms Differing from Those in Fig. 11.

the corner cannot be securely turned without the use of double arms on the corner pole, longer cross-arms should be used and the wires shifted to provide a clear space of 24 inches between the inside line wires and the nearest face of the pole.

Pins.—Before being taken from the yard, each cross-arm should be fitted complete with 1 1/2-inch standard pins. A detail drawing of a standard locust pin, giving dimensions, is shown in Fig 15. Pins should fit tighly into the holes in a cross-arm, should stand perpendicularly to the cross arm when fitted, and be nailed to it with one sixpenny nail driven straight from the middle at side of the cross-arm.

Insulators.—The standard form of insulator for direct-current of all voltages and for alternating-current circuits up to 3500 volts should be the deep groove, double-petticoat, flint-glass insulator. For alternating current circuit exceeding 2500 volts, and not exceeding 5000 volts, the triple-petticoat glass insulator should be the standard. Triple-petticoat glass insulators may also be used for alternating-current

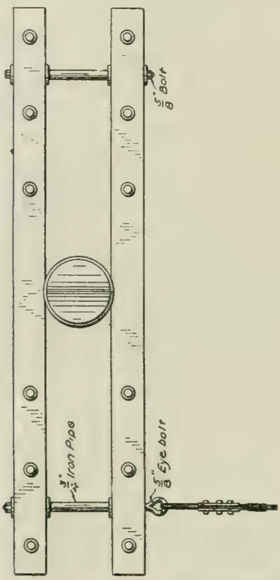


Fig. 13.—A Double Cross-Arm.

circuit under 3500 volts, to reduce noise on telephone wires due to leakage from electric wires on poles jointly used by electric light and telephone wires. For constant-potential lines having a voltage exceeding 5000, special insulators of approved pattern should be used.

Insulators should be placed upon the cross-arm pins only when the wire is to be immediately attached thereto, and should be screwed up tightly in every case. If a wire be permanently removed from an insulator, and no other is to take its place, the insulator should also be removed.

WIRE AND WIRE STRINGING.

Wire Specifications.—Up to and including No. 0 B. & S. gauge, solid wire should be used for lines. Stranded cable should he used for all wire larger than No. 0 B. & S. gauge. No wire of smaller size than No. 6 B. & S. gauge should be used for line wire. For service connections, not more than 75 feet in length, and not crossing a street, No. 8 twin or single conductor may be used. The standard insulation for line wires should be an approved triple-braided weatherproof covering.

Wires Attached to Structures.—High-tension lines should not be supported upon trees, nor should they be attached to buildings. When they must be attached to bridges every effort must be made to so place the wires that they will be entirely inaccessible to the general public. When a high-potential series circuit must be attached to a building in order to supply commercial series arc lighting in the building, the wires must be installed in such a way as to be beyond the possibility of accidental contact by people in or about

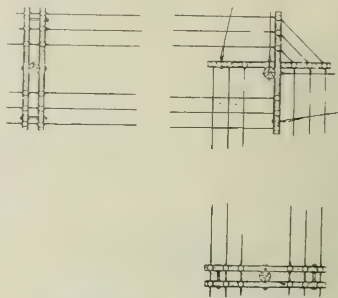


Fig. 14.—A Corner Pole without Double Arms.

the place, and also so as to avoid possibility of contact with awnings, shutters, signs and similar fixtures on the building. Line wires should not be attached to wooden bracket-pins.

Clearance.—The clear space between the crown of the road and wires crossing it should always conform to municipal ordinance or rules, but in no case should such clear space be less than 21 feet. Similarly, the clear space between sidewalks and wires crossing them

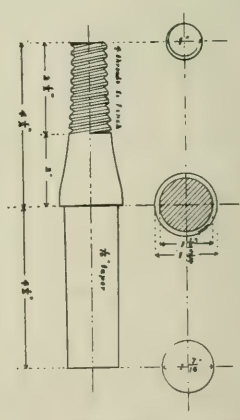


Fig. 15.—Standard Locust Pin.

should never be less than 15 feet. High-tension wires should clear all roofs in such a manner that the wires cannot be reached from the roof. They should clear other wires, or guy wires above or below, by not less than 24 inches except where attached rigidly at poles, and should be rnn so that they cannot be readily reached from any building or structure.

Tree Trimming.—It is essential for the safe and uninterrupted operation of high-tension lines that they be free from the possibility of grounding on trees. It is, therefore, important that tree branches interfering,

or likely to interfere, with the lines should be cut away. Such trimmings must be done with care and judgment and under the immediate supervision of the superintendent, line foreman or other responsible person.

Before any trimming is done, the consent of the owner of the trees should be obtained. Opposition to tree trimming may sometimes be overcome by offering to employ a professional gardener for this purpose. If consent to trim trees cannot be obtained, tree wire should be used. Trees can generally be best trimmed in the fall and winter months, when the leaves are off, and the result of the work will be less noticeable. When branches have been cut off they should not be left to litter the streets, nor thrown into the nearest vacant lot, but should be removed in the company's wagons. The stubs of branches should always be painted for their protection and to make them less noticeable.

Running Through Trees.—When lines must be carried through trees that cannot be cleared or trimmed so as to give a clear passage for the wires, tree wire of approved insulation should be used. This insulation consists of a three-thirty-second-inch rubber cover, taped, and with two braids over all.

Abrasion Moulding.—Where tree wire is used, if there is danger of limbs or large branches chafing the insulation, it should be protected by means of wooden abrasion moulding. A satisfactory form of wood moulding is shown in detail in Fig. 16.

Line Sag.—By means of jack-strap, blocks and tackle or other device, wires should be pulled up until the sag or dip in the line between supports is as specified in Table 2. As will be seen from the table, the dip below horizontal is the same for all sizes of line wire, but varies with the length of the span and with the temperature of the air at the time the work is done. Therefore, wires stretched between two poles should all hang parallel to each other.

TABLE 2.—DIP IN ANNEALED COPPER LINE WIRE.

Deflection in inches.

Span in Feet.	Temperature in Degrees Fahrenheit.						
	30	40	50	60	70	80	90
50	8	9	9	10	11	11	12
60	10	11	11	12	13	14	14
70	11	12	13	14	15	16	17
80	13	14	15	16	17	18	19
90	14	16	17	18	19	20	21
100	16	17	19	20	21	23	24
110	18	19	21	22	24	25	26
120	19	21	23	24	26	27	28
140	22	24	26	28	30	32	33
160	26	28	30	32	34	36	38
180	29	23	34	36	39	41	43

Soft-drawn copper wire, ultimate tensile strength 34,000 pounds per square inch. Triple braided weather-proof insulation. Factor of safety 4. Minimium temperature 20 F.

Splicing Wires.—Every joint and tap should be carefully soldered and taped.

Branch Lines.—When only one or two wires branch from a pole, the tap should be made by the use of spreader brackets, as shown in Fig. 17. If the branch line carries more than two wires, a reverse-arm should be used. All bends in wires should, if possible, be at right angles. When strung in position, all wires should be entirely free from crooks and kinks, and should not hang loosely between supports. Loosely hung or kinked wires are not only unsightly, but are indicative of poor line work. Carrying wires across the face of a pole at right angles, and necessarily without proper supports, not only increases the liability of trouble, and makes trouble-hunting and repair work difficult in the confusion of wires, but unnecessarily makes the wires an eye-sore to the public.

Corners.—At right-angle corners in heavy lines, when possible, turn by means of two poles, as shown in Fig. 8. A corner with only one pole may be turned, as shown in Fig. 7. The double-arms are omitted, if necessary, to provide space for climbing, and the turn made as shown in Fig. 14 and 18. When guys will hold the pole securely, the line wires can be pulled tightly around the corner, but when guys are weak, the strain of the wires should be correspondingly lightened.

Dead Wires.—All wires temporarily out of service should be left on the poles, but should be cut dead, as their connection to a current-carrying circuit only needlessly iucreases the chance of trouble on the lines. Wires permanently out of service should be at once entirely removed from the poles.

Systems of Distribution.—Commercial circuits must be designed to furnish practically uniform voltage throughout a system of distribution, otherwise satisfactory lighting or power service cannot be supplied to consumers. To secure this end, so far as possible, all constant-potential circuits are laid out on the feeder and main system, feeders being run from the station or sub-station to some point of distribution centrally located in the district to be supplied.

From this centre of distribution, the mains radiate in such a manner and are of such a size that the drop in potential will be as uniform as possible, and as low as is warranted by the costs of construction. The drop of potenial in the feeder, between station or sub-station and the centre of distribution, should not exceed 10 per cent. of the delivered voltage. Potential regulators may be used to advantage on feeder circuits, and when the drop exceeds 10 per cent. they should be used.

In general, consumers should not be connected to feeders when they can be supplied from distributing mains or branches. Branch lines or mains on the 500-volt power circuits should be tied together so far as possible, thereby providing an interconnected network of wires throughout a district. Branch lines, or mains, however, supplied by separate feeders, should not be so interconnected.

Temporary Work to be Avoided.—All construction and extension work on circuits should be of a permanent character, both as to the routes followed and the quality of line work. Rush work, short-cuts, skimped materials and other such attempts to hasten the completion or reduce the initial cost of circuit extension, should be avoided.

LOCATION OF WIRES.

Series Circuits.—Series circuits should start from the station, sub-station or other point of distribution on a given pin and cross-arm, and should follow this same relative pin and cross-arm throughout its course. Circuits should not jump from one location on a cross-arm to another location on the same cross-arm, or to a different cross-arm, but should always be placed on their proper pin.

Such a system of confining each circuit to a given pin throughout its course makes trouble-hunting and repair work much simpler than they otherwise would be, and is the only possible way in which circuits can be constructed, maintained, operated and extended in a satisfactory systematic manner. As series arc and

series incandescent circuits are cut dead during the daytime, and will not, therefore, hamper linemen working on a pole, these circuits can often be run to advantage on the pole pins of a cross-arm. Such an arrangement is also convenient for making lamp loop connections.

Multiple Circuits.—The wires of commercial circuits should retain the same relative positions on pins and cross-arms throughout their course, and should not jump from one set of pins to another set on the same cross-arm, or from one cross-arm to another cross-

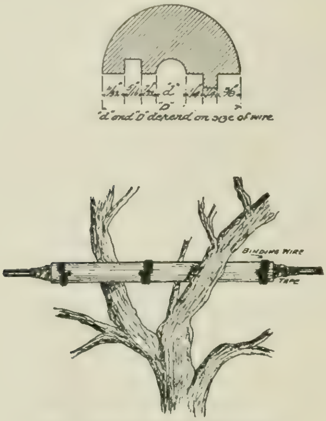


Fig. 16.—Abrasion Moulding.

arm. To minimize the induction on alternating-current lines, the two wires of each circuit must positively be run on adjacent pins of a cross-arm. As these circuits are operated continuously day and night, 2200-volt circuits are preferably located on the adjacent pins at the ends of a cross-arm.

To keep line work as straightforward as possible, and to simplify street lamp transformers and service connections, all through feeders are placed on the upper cross-arms of a trunk line, as far as possible, and all circuits feeding the territory through which the line passes are located on the lower cross-arms. Five-hundred-volt wires can often be advantageously located on the pole pins at the centre of a cross-arm.

Secondary-Circuits. — Secondary mains should be run on the lowest or lower cross-arms, and preferably on the end pins of the arm nearest the side of the street on which the consumers are situated. If, however, secondary mains supply both sides of a street about equally, they should be located near the centre cross-arm. Secondary mains should positively be located on adjacent pins of a cross-arm, and three-wire mains located on adjacent pins and with the neutral wire in the centre.

SECONDARY DISTRIBUTION.

Two-Wire Mains.—Where the service connections of two or more consumers are located within a radius of about 500 feet, they may be fed by the two-wire system of distribution from one centrally-located transformer.

Three-Wire Mains.— Where consumers are comparatively numerous in a given block or district, the secondary mains will be practically continuous, and three-wire secondaries should be employed.

Service Wires.—The service is that portion of the overhead system extending from the mains or transformer secondaries on the pole to the consumer's service outlet on the building. Service connections should not be made with wire smaller than No. 6 B. & S. gauge, except for spans of not more than 75 feet, and not crossing a street, under which circumstances No. 8 B. & S. gauge may be used. In all cases they should be of such a size that the drop from the transformer to the consumer's outlet, including the drop in secondary mains and service connections, shall not exceed 2 per cent. Duplex rubber cable may frequently be used to advantage for service connections where the spans are not excessive.

The regulation method of supporting wires on buildings should be by iron brackets, but with wires not larger than No. 6 B. & S. gauge, carrying not over 125 volts and running along straight, smooth walls, or along the fronts of adjacent buildings, and where there will be no strain on the supports other than that caused by the weight of the wire, approved glass knobs, attached to a building by screws, may be used. All exposed wires on a building that are within 8 feet of the ground should be enclosed in conduit.

Location of Transformers.—Transformers must be installed only on poles or in fireproof vaults, and should not be attached to walls, roofs or other parts of a building. When on poles, transformers should be hung on the face or cross-arm side of the pole. Transformers of 3000 watts capacity or less may be hung at the most convenient location on the line cross-arm and immediately under the primary wires feeding the same. Transformers of over 3000 watts and up to 15,000 watts capacity should be hung on the line cross-arms and astride the pole, the hooks of the transformer hangers being attached to that cross-arm which carries the primary circuit feeding the transformer.

Transformers of over 15,000 watts capacity should be hung astride the pole and on special cross-arms bolted to the pole below the line cross-arms. Trans-

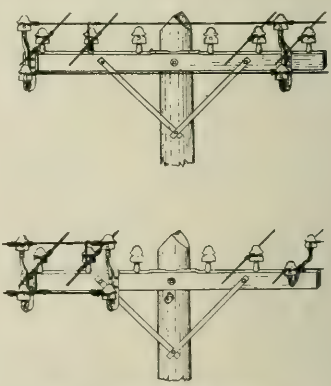


Fig. 17. Branch Line Taps.

formers larger than 30,000 watts capacity should not be hung on regular line poles. Double arms may be used when they will make it possible to feed primary or secondary wires more directly from insulators to transformers than is possible with the single cross-arm.

Removal of Transformers.—Whenever a consumer discontinues the use of a service for a definite short period his service wires should be immediately disconnected from the line, and if he be supplied by an indi-

vidual transformer, this should also be disconnected by removing the fuse plugs. If the stoppage be permanent, or for a long or indefinite time, the service wires and the individual transformer, if there be one, should be entirely removed.

Underground Connections.—When transformers are to be located in basement vaults the latter should be built by the owner of the building, in accordance with the requirements of the National Board of Fire Underwriters. The primary wires running down the side of the pole and underground to the vault should consist

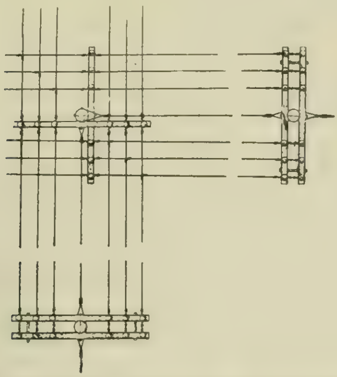


Fig. 18.—Corner Pole without Double Curves.

of an approved lead-encased twin conductor, carried through a conduit.

Pole Wiring.—All wiring on the pole and all apparatus on it should be so located as to leave one side, namely, the back of the pole, free for climbing and working upon. Therefore all primary and secondary connections of transformers, branch taps carried across the pole on spreader brackets, lightning arrester connections and all service connections should be made on the face or cross-arm side of the pole. Also twin conductors carried down the pole for arc or incandescent lamps, and cables and conduits for primary and secondary underground service connections, should be located on the face of the pole.

If it is necessary, in order to clear pole steps or cross-arms, that they be located toward the side, the location selected should be that quarter section of the pole lying between the pole face and the side toward the street curb. All wiring to and from fuse blocks and the primary line wires, or the transformer primary terminals, should be done neatly and securely, and with as little slack wire as possible. Wires should be run horizontally or vertically, and all corners turned with right-angle bends.

The use of duplex conductors for pole wiring is recommended as being both more sightly and convenient than single conductors. This is especially so where wires have to be carried down the side of a pole, and should be used in all such cases. Twin conductors, however, should not be used for primary constant-potential circuit pole wiring unless protected by pole cut-outs.

Fuse Blocks.—To protect both line wire and transformers, there should be inserted in each leg of a primary circuit, where the same connects to a transformer, a single-pole cut-out of an approved type. Such cut-out blocks should always be fused, and the fuse wire of a size to carry not more than 50 per cent. overload on the transformer.

Fuse blocks should be conveniently located on the cross-arm, preferably being placed immediately under the line to which they are tapped. A branch fuse or switch box of approved type should be placed on each leg of a circuit where a set of mains tap to the feeder wires, and also where important branch lines are tapped to the mains. Fuses should be of ample size to carry the normal maximum load on the branch which they protect, and of a size to open the circuit upon a severe overload or short circuit on that branch, without blowing the fuses on the feeder.

The use of branch cut-outs, as described above, is recommended, but not required. Local conditions of operation must be taken into consideration before deciding to locate branch cut-outs, and judgment used in placing them, as the indiscriminate use of such cut-outs might be a source of unnecessary interruptions to the service.

SERIES ARC AND INCANDESCENT LAMPS.

Series Arc Lamp Suspension.—No method of suspension for arc lamps can be rigidly specified, owing to the various conditions and types of lamps to be covered. Whatever system of suspension is adopted should be neat, simple and mechanically and electrically secure. Lamps hung from a rigid support will be much less liable to open-circuit troubles than if their method of suspension allows of much swinging, and for this reason the use of span wires should be avoided.

When lamps must be so hung, the span cable should be a stranded iron or steel cable, and be fitted with a strain insulator at each end. The insulators will be located 6 feet from the supporting poles, as specified for guy insulation. Arc lamps should be

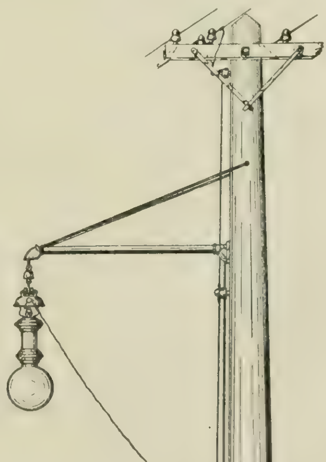


Fig. 19. Inner Rope Arc Light Suspension.

suspended so that the bottom of the lamp will be approximately 20 feet above the ground, and when at such a height, the hanger insulator should be drawn close up to the tail pulley, but not touching it.

When manila rope is employed to lower the lamp, the lamp pulley should have some catch arrangement that will relieve the rope of strain. Every series arc lamp should be equipped with an absolute cut-out of approved type and have a double insulation between the lamp and the supporting rope or cable.

Series Arc Lamp Loop.—When the lamp loop runs down the side of the pole, and this method of constrution is recommended as being both more slightly and reliable than when the conductors are suspended in the air, duplex conductor should invariably be used. This conductor should be No. 8 B. & S gauge, and for arc lamps should have a rubber wall of not less than three-sixty-fourths inch and a covering of braid or tape

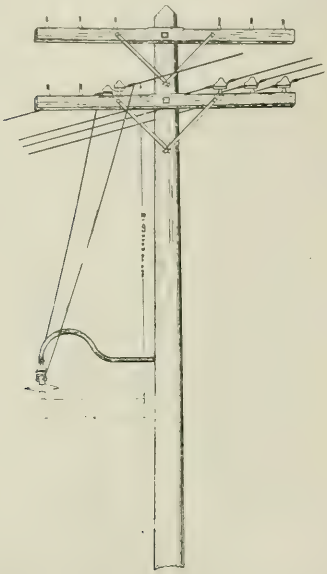


Fig. 20.—Incandescent Lamp Suspension with Separate Conductor Loop.

on each conductor, and with a covering of braid over all.

The duplex conductor, as specified above, should be attached to the pole by means of standard deep groove, double-petticoat insulators on iron brackets, or may be run through an approved insulating conduit that is securely attached to the pole by means of mental clamps. If glass knobs or porcelain knobs or cleats be used, each conductor of the duplex cable should have a rubber wall of not less than three-thirty-seconds inch, and a covering of braid or tape on each conductor, and with a covering of braid over all.

A typical method of series arc lamp suspension that is recommended as being both neat, simple and mechanically and electrically secure is shown in Fig. 19.

Series Lamps Attached to Buildings.—The use of series lamps in buildings, or attached to buildings, should be avoided. Series arc lamps so installed must be located at least 9 feet from the floor, and in every way beyond the possibility of accidental contact by people in or about the place. They should be of a type having a ball-shaped globe enclosing the carbons, holders and the lower frame of the lamp.

The lamps, wires and all fixtures for series arc lighting in buildings should be installed by the company and in accordance with the rules and requirements of the National Board of Fire Underwriters. A switch of approved type that will cut off the current entirely from an installation should be placed at least 10 feet from the floor where the circuit wires are first attached to the building, and at a point at all times accessible from the street.

Series Incandescent Lamps.—Series incandescent lamps will be run on constant-current circuits controlled by some form of regulator, preferably automatic, located at the station or sub-station. It is recommended that shunt box or similar systems be not used. Each series of lamps should be run from the regulator on a separate circuit, common returns for two or more series being avoided, and the series circuits throughout should be electrically independent of the commercial service.

The lamps should be suspended from poles on fixtures of an approved type, having insulated heads, and lamp sockets with approved cut-outs. Fixtures should be of such length and so attached that the lamp will be 3 feet 6 inches from the pole and 14 feet above the street, unless otherwise specified by municipal contract. They should be firmly attached to the pole by means of two 4-inch lag bolts. If the series circuit to which an incandescent lamp is to be connected is on the same side of the pole as the lamp fixture, if there are no intervening cross-arms or line wires between the circuit and the fixture, and if the drop does not exceed 15 feet, the connection to the lamp may be made by dropping the No. 6 B. & S. line wires from the break-arm insulators in the circuit to the line insulators at the lamp end of the fixture, as in Fig. 20.

If the circuit is on the opposite side of the pole from the fixture, so that wires installed as above would cross the pole, or if there are intervening arms or line wires, or if the drop would exceed 15 feet, then the connection to the lamp should be made by means of rubber-covered duplex conductors attached to the pole and installed as in Fig. 21. It is recommended that duplex conductors be used in all cases for series incandescent lamp loops.

GROUND CONNECTIONS.

Grounds for Lightning Arresters.—When lightning arresters are to be placed on a pole special attention

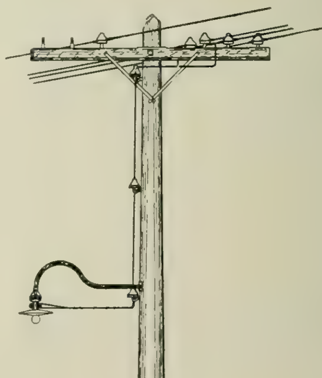


Fig. 21.—Incandescent Lamp Suspension with Duplex Conductor Loop.

should be given to making a good ground connection.

A piece of No. 4 B. & S. gauge insulated copper wire should extend down the pole from the arrester located to a suitable ground, as hereinafter specified. The ground wire should be as short, straight, and free from coils or turns as possible, and run down the side of the pole enclosed in a half-round wooden moulding. The moulding should extend to a depth of at least 6 inches below the surface of the ground. The part of

the ground wires below the surface of the ground should be cleaned free of insulation. This ground wire is preferably carried under the ground in as direct a line as possible to the nearest service water pipe and connected thereto by being sweated into a lug attached to a clamp, the clamp being firmly bolted around the pipe. The water pipe should be cleaned bright before the attachment is made, and the clamp and part of the pipe adjacent to it painted with asphaltum paint after the connection has been made.

If no water pipe is available for a ground connection the ground wire should be attached to a plate of No. 16 B. W. G. copper containing not less than $4\frac{1}{2}$ square feet of surface, and should be riveted and soldered securely to both surfaces thereof. If the soil at the base of the pole is suitable for a good ground the pole hole should be dug 1 foot additional in depth, or if the pole is already set, a hole not less than 6 feet in depth shall be dug beside the pole, and a 6 inch layer of crushed charcoal or coke placed in bottom of same.

The copper ground plate should then be placed on the coke and covered by an additional layer of 6 inches of crushed charcoal or coke. If the soil at the butt of the pole is not suitable, the plate should be placed in a bed of charcoal or coke as specified above, in a hole which will furnish a suitable ground as near the pole as possible, the ground wires being run under the surface of the ground in as straight a line as possible from the foot of the pole to the ground plate.

Grounding of Low-Potential Circuits.—The neutral wire of three wire, direct-current circuits should be grounded at the central station and also every 500 feet in overhead lines. The secondary system of all distributing transformers should be grounded. This should preferably be done at each consumer's installation by a ground wire connection from the service outlet to the city water pipe system, as called for and described in the paragraphs covering the grounding of secondaries in the company's wiring rules.

INSPECTION OF LINES.

Every portion of the outside overhead construction of the company should be carefully inspected at regular intervals by an inspector detailed for the purpose, and where found to be in a condition, either through accident or decay, or from any other cause, that might make an accident of any kind possible, should be repaired at once, the repairs being carried out in accordance with these specifications.

This inspection must cover all poles, guys, lines and line apparatus belonging to or operated by the company, either on public highways or on private property and all attachments of the company on foreign poles. It must also cover the attachments, of whatever kind, made to the company's poles by foreign companies, and all conditions affecting or likely to affect the safe operation of the company's lines.

Any conditions found in the construction of a foreign company that might affect the safe and uninterrupted operation of this company's system should be immediately reported to the poper officials of such foreign company so that the same can be corrected. The inspectors should be supplied with suitable note-books or blank pads on which to note defects in the line construction of the territory covered, which should be turned in daily and immediatly attended to by the repair department.

HOW TO BALANCE PULLEYS.

It is surprising to note how an otherwise capable mechanic goes about the seemingly simple process of balancing pulleys and other revolving parts. I saw a first class machinist place an 8 foot section of line shafting which had several pulleys on it between centers in a lathe, to balance it, after the manner shown

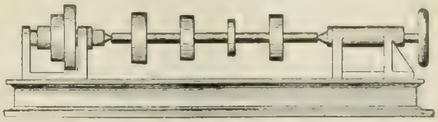


FIG. 1.—WRONG WAY.

in Fig. 1. Of course he failed and the job had to be done by somebody else.

Another machinist, who ranked very high, did something even more incongruous. A countershaft with three pulleys on it was brought into the shop to be balanced. The man got two V-shaped blocks, set them level and dropped the ends of the shaft into the grooves, as shown in Fig. 2. The foreman ordered

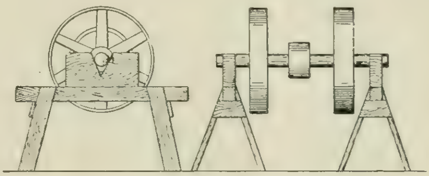


FIG. 2.—ANOTHER WRONG WAY.

the shaft removed from the V-blocks, but the man did not take any of the pulleys off the shaft, but tried to balance them altogether, so the work had to be done over by another workman.

Every engineer would do well to have in his tool box two steel straightedges, about 15 x $1\frac{1}{4}$ x $\frac{1}{4}$ inches. These can be let into wood and placed on blocks or horses which have been leveled especially for balancing work, as shown in Fig. 3. Only one pulley should be

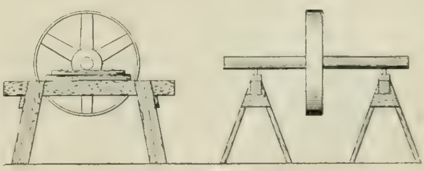


FIG. 3. CORRECT WAY.

put on the shaft at a time, as it is impossible to balance more than one pulley at once.

Balancing a very wide pulley, or a drum, presents a very difficult problem, and it is hard to find which end is out of balance. I have seen drums 3 feet long run in loose bearings very rapidly, while chalk was held to the shaft to mark the side which was thrown out of true by centrifugal force. The heaviest part of the rim being shown in this manner, weights were added to the opposite side to effect a balance. Theoretically, when a revolving body is in balance, every part is balanced. That is, if any number of sections were cut through it at right angles to the centre, or line of revolution, no matter how closely together, each section should be balanced. Of course, this condition is almost impossible in practice. "J. P. H." in Power.

CANADIAN

Electrical News

AND ENGINEERING JOURNAL

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

Liquid Air. We feel safe in predicting a repetition of the liquid air boom similar to that which took place some years ago on the introduction of the Tripler system. We are advised that a new process has been patented in England by a man named Knudsen, by which the cost of liquid air is reduced to about two cents per gallon. Prior to Tripler's invention, liquid air had been exhibited in London in teaspoonfuls, and even then the cost of producing such a small amount was extremely high. Tripler's system was simplicity itself. We do not remember the cost per gallon, but it was evidently low enough to permit the indiscriminate use of the fluid for all kinds of insignificant experimental work. His first machine consisted of a triple cylinder air compressor, the stroke of which was about twelve inches. The first cylinder was about twelve inches in diameter, and compressed the air to about one hundred and fifty pounds per square inch. At this pressure the air passed to the second cylinder, which was about five inches in diameter, and was there compressed to seven hundred and fifty pounds per square inch. It then passed through a third cylinder, which was single-acting, and just the size of the piston rod, and was compressed to about two thousand pounds per square inch. At this pressure its temperature was exceedingly high, and it was therefore passed through cooling coils from which it emerged at atmospheric temperature. It was then led to a series of coils in a heavily insulated box. The piping doubled back upon itself, and the air was liberated through an expansion valve close to the point where the pipe originally entered the compartment. The expansion of the air from such a high pressure produced a very low temperature, which cooled the air in the coils in the chamber. The colder this chamber became, the lower was the temperature of the air just prior to expansion, the process working out along lines similar to the regenerative furnace. Eventually a sufficiently low temperature was reached to liquify the air. So far as we can judge, the Knudsen process is identical with the Tripler, though probably the apparatus is so changed about in detail as to greatly reduce the cost of manufacture. The future of liquid air promises nothing, the proposal to use it in automobiles being ridiculous. A British paper commenting upon this proposition condemns the idea in the following trite phrase: "Automobilists then are invited to buy liquid air at a price twelve hundred times as great as an equivalent quantity of steam power.... and a ten horse power carriage for a ten hour spin must carry a ton and a half of liquid air, requiring a tank of approximately seventy-two cubic feet capacity for its storage, to all sides of which there must be added at least six inches of insulation. Liquid air is a most troublesome and unstable fluid, which must itself be first produced by an expenditure of an infinitely greater amount of power than the fluid possesses."

Denaturized Alcohol. The possibility of a universal use of an industrial alcohol has received much comment both from the technical and daily press since the action of the United States Congress in removing the tax from such an article. The price at which alcohol has been sold in the past has created in the public mind an impres-

sion that this liquid is decidedly expensive to manufacture, whereas the truth of the matter is that this high cost is due entirely to the very heavy government tax. Every still has to be licensed, and every gallon of alcohol produced is subject to the tax above mentioned. The result has been a very limited use for domestic purposes, and many of the articles from which commercial alcohol can be produced are now thrown away as waste products. So far as the cost of manufacture of alcoholic stimulant is concerned, we know of a case in Cuba, some years ago, where prior to the introduction of a tax on this article, some six hundred thousand gallons of rum was sold by a sugar estate for approximately nine cents a gallon. Considering that a profit, and a material profit at that, was made in this transaction, and also that the selling price in the States would probably be in the neighborhood of three dollars per gallon, one gets an idea of the severity of the government tax, and this will be more than confirmed if reference be made to the figures available at the Inland Revenue Department. We also have similar experiences in our own country, where, prior to the introduction of the tax, stimulants were sold retail at approximately twenty cents per gallon. Of course, one of the material considerations in connection with the taking off of the tax is that the alcohol must be rendered absolutely unfit for drinking, and hence the name mentioned above has been given to the product. We understand that the substances from which alcohol may be obtained are practically innumerable, any article containing sugar, or starch which can be converted into sugar, giving a greater or less quantity. The alcohol is produced mostly by distillation, though fermentation or a combination of the two is quite common practice. The apparatus required is exceedingly simple, and the process, judging from the figures above given, can hardly be termed expensive. We have record of one person who was convicted of illicit distilling in the south, whose entire apparatus consisted of a tin coffee pot, a short length of tubing immersed in a trough of water (which acted as a condenser), and a pint bottle into which the condensed liquid ran. There is a public impression that with the removal of the tax, any one will be allowed to manufacture alcohol, but this is very far from the truth, as such an arrangement would doubtless be abused in a most severe manner. The alcohol will still be made under government supervision, and the stills licensed under the method in vogue at present. Possibly greater care will be exercised in the testing of alcohol intended for commercial use, to insure the certainty of its being unfit for drinking purposes. Prior to the great demand for gasoline for use in internal combustion engines, a high grade of this article could be purchased in barrel lots in New York city for seven or eight cents per gallon, but with the immense increase in demand experienced in recent years, the cost has steadily increased to a point when in Canada a figure of twenty-five cents per gallon has been reached. Industrial alcohol will occupy in the very near future a position with regard to gasoline similar to that held by aluminum with regard to copper, with the great difference that the industrial alcohol will be very much cheaper, as its source is universal and practically unlimited. We find that in Germany the greatest advances have been made in the manufacture and utilization of industrial alcohol. That country produces no petroleum whatever, and the government realized that in case of war their machinery operated by internal combustion engines might be rendered useless through a lack of fuel. Hence, action was taken to encourage two things, first, the production of denaturized alcohol, and second, the development of engines suitable for its use. Prior to this action, the distillation of alcohol was subject to the same severe tax as found in other countries, and naturally the removal of this tax was one of the first steps to be accomplished. Since that date, the development in Germany and in other continental countries of engines designed for use of industrial alcohol, there known as "petrel", has been very rapid, and it is probable that the quantity of petrel so used exceeds the gasoline consumption many times. There exists, of course, a general impression that when the tax is removed in the States on January first, nineteen hundred and seven, industrial alcohol will immediately find an immense market. This, of course, is based on a misapprehension, for probably it will be many years before internal combustion engines are sufficiently developed for alcohol to give the same satisfactory results as gasoline engines. It is far from a simple matter to convert a gasoline or a kerosene engine into one which will give satisfactory results with alcohol, precisely in the same way that the gasoline engine to-day is not suitable for use with kerosene any more than the kerosene engine can be used with alcohol. Each fuel presents certain marked peculiarities, which, while similar in many ways, are yet sufficiently distinct to require individual consideration. A change of carbureters alone does not suffice, as there are many points which must be incorporated into the engine to make it suitable for the particular fuel which is intended to be used. In the United States and Canada we are of course at a tremendous advantage, for we have before us the experiments and failures of years of the German engine builders. These will be guides of inestimable value, and it is to be hoped that the development of a thoroughly reliable alcohol engine will be a matter of months rather than years. We anticipate, of course, that the Dominion Government will immediately follow the action of the United States in the removal of the alcohol tax, for the internal combustion engine even to-day occupies a very important position in our industrial world.

SPARKS.

The Stuart Turbine Company, Limited, of Montreal, was incorporated last month, with a capital of $20,000, to manufacture the Stuart turbine engine. Mr. H. A. Allen, steamship owner, is one of the incorporators.

The Montreal Light, Heat & Power Company have instituted an action to recover an indemnity of $10,000 for the Ambursen Hydraulic Construction Company, of Boston, for non-fulfilment of contract. It is claimed that the American firm undertook to do certain work at plaintiff's plant at Chambly, but that it has failed to carry out its obligations.

The town of Dartmonth, N.S., has awarded the contract to the Canadian Fairbanks Company, Limited, for a complete lighting plant for the town, consisting of a 150 h.p. Fairbanks-Morse suction gas producer plant and a 10 k.w. alternater, to be belt driven. The Canadian Fairbanks Company will make the complete installation, consisting of the producer engine, alternator, switchboard, etc.

INVENTION AND DEVELOPMENT
IN THE ELECTRICAL FIELD

Distribution at 4,600 Volts.—An unusual feature of the Toledo Gas, Electric & Heating Company's system at Toledo, Oregon, is the use of 4,600 volts as a distributing primary pressure instead of the more usual voltages in the neighborhood of 2,000. The high-pressure network, which is overhead, is three-phase, with the generator windings star-connected and the neutral point earthed. The transformers are distributed about the town, and the secondary network is at 115-230 volts. The same company also carry on a hot-water heating business. This was formerly supplied by the exhaust steam of the electric light station, but since the establishment of a new generating station equipped with steam turbines, this arrangement is to be abandoned and the heating system will be supplied with hot water direct from the boilers of the old station. Motor-driven centrifugal pumps will be used for circulating the hot water.

Recording Apparatus for Electric Railway Tests.—An arrangement for obtaining simultaneous records of current, voltage, speed, etc., of electric cars is described in the Street Railway Journal. The paper strip is driven by a spring motor of the type employed in phonographs. The records are traced by pencils mounted on travelling carriages and each controlled by a cord passing round a pulley, attached to a disc carrying a pointer, which is caused by hand to follow the movements of the pointer of the voltmeter, ammeter, or other instrument, as the case may be. The disadvantage of the method is the necessity for a number of more or less skilled observers continually watching the instruments. A contact worked by a clock energizes an electromagnet every half second, which marks a scale of time on the record, and each revolution of the car wheel is recorded in a similar way. The form of speed indicator employed consists of a small magneto-generator mounted on the truck and belted to one of the axles, in combination with an ordinary Weston voltmeter.

Magnet Coils for Arc Lamps.—An American patent has recently been issued to Prof. Elihu Thomson for a process for insulating coils which must withstand excessive moisture and high temperature. Each coil is composed of a single helix of ribbon copper, wound edgewise with the turns close together, so that it forms a tube, the thickness of whose wall is the width of the ribbon conductor. After the coil is wound, and while there is still some space between the convolutions, it is covered by immersion with an insulating and cementing compound, consisting of kaolin and silicate of soda. The proportions of these two ingredients are such that the mixture is a viscous liquid, like a water varnish, which will soak into all crevices and form a thin layer between the metal coils. The entire coil is then closed together to form a rigid structure, and is subjected to a low red heat, until the insulating compound is vitrified into an insoluble moisture-proof cement which binds the coils together without permitting contact between its turns. This insulation is a double silicate of aluminum and sodium, and is refractory, being incapable of complete fusion except at a temperature which would melt the copper.

Alternating-Current D'Arsonval Galvanometer.—Professors' Franklin and Freudenberger have constructed a form of alternating-current D'Arsonval instrument of the shunt magnet type. The electromagnet has a laminated core and is excited from alternating mains through an adjustable choking coil and condenser, in such a manner as to have the alternating magnetic flux substantially in phase with the e.m.f. between the mains. When the movable coil is traversed by this flux an alternating e.m.f. is induced in it, as in the secondary coil of a transformer. As soon as the circuit of the movable coil is closed internally a secondary current is induced therein and a unidirectional pulsating torgue is hereby set up on the coil, even although no current is supplied to the coil from an external source. The coil is, however, allowed to assume a definite position under this torque, by means of an adjustable external resistance, and then the alternating current to be measured is superposed upon the steady secondary current in such a manner as to bring about a measurable deflection. It is stated that the sensitiveness of the alternating-current D'Arsonval galvanometer is of the same order of magnitnde as that of the direct-current instrument.

Secondary Conductor Arc Lamps.—In an article by E. Stadelmann-Nehein published in a recent issue of the Elcktrotechnische Zeitschrift, the use of rare earth auxiliary or secondary conductors for arc lamps is discussed at some length. The arrangement consists essentially of a third conductor composed of a slab or block of rare earth composition placed alongside, but not touching, the ordinary carbon electrodes of an arc lamp. The lamp is lighted as an ordinary arc lamp without reference to the third conductor. When the arc is struck the heat transmitted to the rare earth block is such as to raise it to the point of conductance, and a portion of the lamp current is shunted across, and passes from carbon to carbon by way of the auxiliary conductor. It will be seen that the carbons can now be drawn a considerable distance apart, and the space between each carbon and the secondary conductor also preserved sufficiently large to prevent any actual contact. Light is thus produced from the electrodes, the arc, and also from the secondary conductor. The result is an extremely efficient and steady light, which gives the strongest effect downwards or, in fact, in any desired direction according to the arrangement of the conductors. The author of the article testifies that chamotte is up to the present the most suitable material for the secondary conductor, since it withstands the arc well and, although it softens, it does not form into drops. Tests of these lamps are to be made, and investigations continued towards securing the best material for the secondary conductors. These results will be awaited with interest, and in the meantime there are doubtless many who will be prompted to experiment in this particularly promising branch of electric lighting development.

REDUCTION IN COST OF ILLUMINATION.

The past year has witnessed a remarkable renaissance of efforts directed toward reducing the cost of producing light, and improving the methods of utilizing it for illumination.

The Luminous or Flaming arc lamp produces light at a cost not exceeding one-quarter of that required by the enclosed arc. The Magnetite arc produces light of not more than one-half the cost of the ordinary arc, and it seems not unlikely that it will develop a still higher efficiency. The Tantalum incandescent lamp has an efficiency of practically twice that of the old form of carbon filament lamp, and it is asserted upon good authority that the Tungsten lamp, on the same principle, will give double this efficiency, i.e., have an efficiency of one watt per candle. Filling the gap between the arc and incandescent lamps, the Mercury Vapor and Vacuum Tube systems may be considered, both of which have reached the practical stage, and have efficiencies far in excess of the present incandescent lamp. Thus throughout the entire field of electrical lighting, it is conservative to assume that a given amount of light can be produced at the present time with one-half the cost that was req· ired by the best devices known a few years ago.

The reduction in cost of light production by electricity must necessarily change to some extent the relations of electric and gas lighting. Gas light has held its own by reason of its great superiority in cost of production. The halving or quartering of the cost of electric light, however, might very seriously change this advantage heretofore held by gas. The limit of cost of gaslight, however, has by no means been reached. It is a well known fact that very much higher efficiency may be obtained by using either the gas, or air supply, or both, at a higher pressure than is now the practice in this country, and gas lamps based upon this principle are being largely installed for exterior lighting in England.

Several attempts have been made to establish "intensive gas light," as this system is called, in this country, but so far as we are aware, without commercial success. There seems to be no reason, however, why the price of gas to consumers should not be reduced without entailing a corresponding loss to producers. We can see no sufficient reason for the manufacture of illuminating gas, i. e., gas giving a luminous flame, under present conditions. To be sure, ordinary flame gas burners are still numerous, but there is no reason why they should not all be supplanted with incandescent burners or electric lamps. A gas capable of producing the best of results with incandescent burners, and suitable for all heating purposes, could undoubtedly be made and delivered at a good profit at a cost very materially below that at present charged for illuminating gas; and even though the percentage of profit were reduced, the increased use of a cheaper gas for fuel purposes would bring larger aggregate returns to the producing companies. Towns having a supply of natural gas, which is non-luminous, get on perfectly well with it for both heating and lighting purposes, and why should not a similar gas made artificially answer all purposes equally well?

It has long been recognized that in the use of light to produce illumination excessive waste has been the rule, rather than the exception. This fact, together with the increasing complexity of uses for artificial light, as well as the greater number and variety of light sources and accessories, has at last given rise to an established profession, namely, Illuminating Engineering. While exact figures as to the economies accomplished by Illuminating Engineering are few, from cases with which we are familiar, in which actual results have been obtained, as well as from the possibilities of numerous cases investigated, it is perfectly safe to say that a reduction of 25 per cent. in the cost of illumination is a low average of the saving that can be thus effected.

When the improved light sources that are now on the market, or in process of development, are utilized to their very best advantage by the skill of the Illuminating Engineer, illumination of a superior quality will be produced at from one-quarter to one-half the present cost. While greater economy in the production of illumination is therefore inevitable, there is no likelihood of any one particular form or source of light obtaining a monopoly of even a single department of the illuminating field. The total result will be a larger general use of artificial light, and the production of more satisfactory illumination.—The Illuminating Engineer.

TRADE NOTES.

The Electrical Maintenance & Repair Company, Toronto, are moving into more commodious premises at 162 Adelaide street west, where they will occupy the two upper flats. The change will afford them much greater facilities for the execution of their rapidly growing business.

The firm of Brown, Boveri & Company, Limited, electrical engineers and contractors, Baden, Switzerland, are establishing a branch company in London, Eng., of the same name, to look after the interests of the parent firm in Great Britain, Canada and other colonies. This company will take over the contracting business of Whiting, Eborall & Co., London, and Mr. A. C. Eborall will be managing director of the new firm.

The Electric Control & Supply Company, Cleveland, Ohio, announce the opening of a Chicago office in the Merchants Loan and Trust Building, 135 Adams street, with Mr. W. M. Connelly in charge. Mr. Connelly was connected with the electrical department of the Homestead works of the Carnegie Steel Company for five years and resigned his position there to become electrical engineer of the Ensley plant of the Tennessee Coal, Iron & Railroad Company at Birmingham, Ala., which position he held for three years, resigning to enter central station work at Birmingham, Ala., and at Houston, Ten.

The Yukon Consilidated Goldfields Company, Limited, have contracted with the Canadian Westinghouse Company for the following electrical apparatus to be used in gold dredging in the Yukon Territory: Three 100 h. p. 3-phase, 60 cycle, 400 volts, type F motors; three 15 h. p. 3-phase, 60 cycles, 400 volt, type F motors; three 50 h.p., 850 r.p.m., 3-phase, 60 cycles, 400 volt constant speed induction motors; three 30 h.p. motors; three 20 h.p., 1,120 r.p.m. motors; three 15 h.p. 850 r.p.m. motors; three 7½ h.p., 1,700 r.p.m. motors; nine 75 k. w., oil insulated, self cooling transformers; two 625 k. w., 3-phase, 60 cycles, 2,200 volts, 415 r.p.m., a. c. generators, and two 17 k.w., type S exciters for same; one 4 panel switchboard for controlling above; four 250 k.w., oil insulated, oil cooled transformers and four 200 k.w. transformers, same type.

The Havelock Electric Light Company have installed another water wheel in their power house, thereby increasing their plant to the extent of 300 h.p.

The Hamilton, Grimsby & Beamsville Railway will probably be extended from Beamsville to St. Catharines. The repairs to the Grimsby sub-station, which was damaged by lightning recently, have been completed.

MONTREAL

Branch Office of The Canadian Electrical News,
Room B33 Board of Trade Building.

October 5th, 1906.

Montreal is experiencing perhaps the busiest year in its history. The amount of building is greatly in excess of last year, and everywhere one meets the report of great activity, a heavy demand for goods, and remunerative prices. The electrical machinery and supply houses are working to the limit of their capacity, but customers do not now expect as prompt delivery as could be secured a few years ago when business was less prosperous. As a natural result of large building operations, there has been a good demand for wiring material, the supply of which is getting short. The factory building of Henry Morgan & Company on Beaver Hall Hill furnishes an example of very neat work. It is done in condulet, the method of suspending the pipe being somewhat unique. The construction engineer, Mr. C. J. Young, regards it as one of the finest jobs in Canada.

We learn from Mr. R. S. Kelsch, the consulting engineer for the Montreal Light, Heat & Power Company, that they are about to increase their capacity by installing a 1,500 k.w. three-phase generator of Westinghouse manufacture, to be driven by a Westinghouse-Parsons turbine of 2,500 h.p. Mr. Kelsch is now laying out the work at the Soulanges power house of the Montreal Light, Heat & Power Company. The turbines will be supplied by Allis-Chalmers-Bullock, and the electrical apparatus by the Canadian Westinghouse Company. There will be three 3,750 k. w., 4,400-volt, three-phase, 60 cycle generators, two exciters of 200 k.w., and thirteen 3,500 kilowatt transformers, together with complete main station and sub-station switchboards and lightning arrester equipment.

The Montreal Street Railway Company have contracted with the Canadian Westinghouse Company for a 1,000 k.w. railway generator, three 500 k.w. motor generator sets, and twenty quadruple equipments of motors and fifty sets of air brakes with motor driven compressors.

The new power house of the Sherbrooke Power, Light & Heat Company is practically completed. It is a fine concrete building, the installation consisting of three 650 h.p. turbine units, three 500 k.w., three-phase, 2,300-volt C.G.E. generators, two 50 k.w. exciters and a twenty panel switchboard. The plant was designed by Mr. R. S. Kelsch, C. E., of this city.

A number of prominent gentlemen representing the electrical interests are taking steps to have an Electrical Trades Exhibition next year which will do credit to Canada and increase the public knowledge of the various applications of electricity. It is understood that a company is about to be incorporated and an announcement will be made at a very early date.

The Iberville & St. Cesaire Hydraulic Power Company, which recently acquired the property of the St. Cesaire Power Company at St. Johns, Que., are now building a new steam plant at St. Johns of 600 h. p. capacity to act as a reserve plant in connection with the water power service from St. Cesaire. We learn from Mr. C. Brandeis, consulting engineer for the company, that the contracts have not yet been let. The Iberville & St. Cesaire Power Company have a three-phase transmission line twenty-one miles in length, 16,500 volts, of No. 2 aluminum wire.

Veritys, Limited, of London, Eng., large manufacturers of electrical apparatus and supplies, have appointed Mr. Hugh B. Morris as their representative, with headquarters in Montreal.

Nearly all the electrical supply houses are increasing their facilities in order to handle their growing business. We learn from Mr. Irving Smith, vice-president and general sales manager of the R. E. T. Pringle Company, that their new factory at St. Henri is completed and running smoothly. It is a five-storey building of modern construction and is an evidence of the rapid growth of the Pringle Company since the business was established about ten years ago. It was found necessary to build the factory in order to supply their Montreal warehouses and branches at St. John, N.B., Toronto, and Winnipeg. The Pringle Company are constantly adding new lines and are now one of the largest manufacturers of electrical supplies in Canada.

Messrs. Munderloh & Company are erecting a new building at the north end of Victoria square. It will be four stories and basement, with a frontage of 56 feet and a depth of 125 feet, and will have a stone foundation, brick walls and concrete floors, columns and beams, making it as nearly as possible fireproof. Most of the building will be used as a factory and warehouse for electrical supplies, but it will also contain the general offices, the intention being to vacate the present premises on St. Sulpice street. The new building, which was designed by Messrs. Hutchinson & Wood, the well-known Montreal architects, is expected to be completed by February of next year.

Messrs. J. A. Dawson & Company have recently secured additional space in their building at 293 Craig street west. They are now occupying practically the entire four stories, the sales department being located on the first floor, the general offices on the second floor, while the top floors are used as stock rooms. A portion of the second floor is set apart for the winding of street railway motors, which is an important department of their business. Messrs. Dawson & Company have just been appointed sole Canadian agents for the Couch & Seeley Company, telephone manufacturers of Boston. They are also placing on the Canadian market the Jackson instantaneous wrench manufactured by the Union Tool Company, of Boston. A few months ago they established a branch in Winnipeg, in charge of Mr. R. S. Carter, where a complete stock of all lines is carried.

The Duncan Electrical Company are now manufacturing a lamp guard which they claim is unequalled for strength, durability, appearance and cost. Type "B" is made to fit porcelain sockets, as they are standardizing both the porcelain socket and the porcelain key in order to take the guard. The guard is fastened to the socket, not to the lamp. Other new lines which they are placing on the market consist of receptacles of neat design, rosettes with patent clamp which makes full contact the length of cleat, wall sockets, and sockets for use in street cars. Mr. Charles Duncan, manager of the Duncan Electrical Company, is the designer of the new lines, and Messrs. J. A. Dawson & Company have been appointed general sales agents for their products.

The repair shop of Messrs. Fred Thompson & Company is running over-time. They are now remodelling plants for four different towns, as follows: One of 1,000 lights, 1,000 volts, one of 750 lights, and one of 500 lights, all alternating current, and one of 250 lights, direct current. They have just supplied a second balancer set for the Central Light, Heat & Power Company, of Montreal.

The Sayer Electric Company have opened a new branch at 801 St. Lawrence street to meet the large demand for electrical supplies resulting from the rapid growth of the north end of the city.

Messrs. Collyer & Brock are busy supplying wiring material, fittings, etc. They report that conduit work is now becoming very general.

Mr. W. J. O'Leary has recently organized the Auto-Safety Electric Switch Company, for the purpose of pushing the sale of the Auto-Safety switch invented by Mr. W. J. Plews and which has for some time been manufactured under royalty by W. J. O'Leary & Company. The new company have offices in the Board of Trade Building.

Messrs. Plews & Trimingham, of the Electrical Inspection Bureau and Testing Laboratory, are now issuing approval cards of electrical products which have been submitted to them for examination and test and which have proven satisfactory. These cards will be issued quarterly to all parties who are interested in the use of electrical supplies, the object being to reduce to a minimum the electrical fire hazard introduced by the use of inferior materials. These certificates are accepted by the Canadian Fire Underwriters' Association. Messrs. Plews & Trimmingham report that the Electrical Inspection Department of their business is steadily growing. They inspect electrical installations at a regular schedule of charges. For instance, the charges for generators, motors and transformers range from $1 for 15 h.p. to $20 for more than 200 h.p. and an additional charge ranging from 30 cents per h.p. for 15 h.p. down to 5 cents per h. p. for machines above 200 h.p. For the inspection of concealed wiring, including conduit work, the charge is 10 cents per outlet up to 100 outlets, and for open wiring, including fixtures, fittings, etc., 10 cents per light up to

100 lights and a graded scale down to a mienimum of 5 cents per light for 500 lights and upwards.

The Sovereign Light, Heat & Power Company is the name of a new concern who are requesting, through their lawyers, Messrs. Vipond & Vipond, a franchise from the city of Montreal for gas as well as electric light. This is the outcome of the Aldermanic desire for cheaper gas, but as the new concern has not yet secured their charter, and the names of its backers have not yet been made public, it is doubtful if any real interest will be taken in their offer. The Sovereign Company state also that they would supply cheaper incandescent light, and it is rumoured that a young firm here have been retained as their consulting electrical engineers.

The town of Westmount having been approached by some private residents living contiguous to the boundary of the city of Montreal relative to furnishing electric current, courteously requested permission from the city of Montreal to allow them to swing their wires across the said boundary street for such purpose. The worthy aldermen of Montreal, with that keen insight which has always distinguished them and made them so dearly beloved by the business community in general, immediately got vastly excited and wanted to know what the price would be, that Westmount should make a remarkably good offer, etc. As a matter of fact, it is none of the city aldermen's business what any of their private residents choose to pay for electric light, and the question solves itself merely into one of "May I cross your road?"

Mr. Wayland Williams, who for the last two years has represented the Campbell Gas Engine Company, has now assumed charge of the gas engine department of Messrs. W. H. Laurie & Company, Board of Trade Building, Montreal, the Canadian agents for the well-known Crossley gas engines, suction gas producers and the Loomis-Pettibone producers.

PERSONAL.

Mr. J. W. Pilcher, district manager at Montreal for the Canadian General Electric Company, has recently returned from a vacation in the Maritime Provinces, where he was district manager for a number of years. His assistant, Mr. W. P. Roper, had charge during his absence.

Mr. A. B. Smith, Superintendent of Grand Trunk Pacific Telegraphs, is at present in Winnipeg in connection with the construction of the telegraph system in the west.

It is understood that Mr. J .L. Belnap, Winnipeg manager for Allis-Chalmers-Bullock, Limited, has been appointed to succeed Mr. R. A. Stinson as district manager at Montreal. Mr. Zavitz, who has recently been located at Vancouver, will assume charge of the Winnipeg office.

Mr. W. A. Lewis, representing J. A. Dawson & Company, is at present on a business trip in the Maritime Provinces.

Mr. R. J. Hiller has been engaged as supply traveller by the Montreal office of the Canadian General El ctric Company.

Mr. M. Rubenstein, chief contracting agent for the Montreal Light, Heat & Power Company, has severed his connection with that company and we are given to understand will engage in the electrical contracting business on his own account.

NEW SELLING AGREEMENT.

Considerable importance will be attached to the announcement made by the Packard Electric Company, to the effect that Mr. Russell A. Stinson and Mr. Frederick J. Bell have become associated with the company and assumed charge of their eastern office at Montreal on September 15th, the territory covered being that from Kingston east. The services of Mr. J. J. Warren, who has been acting manager, will still be retained and other additions made to the office staff in order to take care of the increasing business. The Montreal offices of the company have been removed from the Street Railway Chambers to more commodious quarters in the Bell Telephone Building, corner Notre Dame and St. John streets.

The Packard Electric Company have the exclusive right in Canada for the sale of the well-known Crocker-Wheeler apparatus, as well as the Jandus Electric Company's arc lamp equipments, and in entering into this new selling agreement they feel that their customers in the eastern territory will be given every attention. Both Messrs. Stinson and Bell are widely known in the electrical field. Mr. Stinson was for upwards of ten years associated with the Canadian General Electric Company in the capacity of sales agent, but joined Allis-Chalmers-Bullock, Limited, upon its organization about three years ago, being district manager for Montreal. This position he retained until the formation of the present partnership on September 15th last as eastern representatives for the Packard Electric Company.

Mr. Bell was first employed in the Peterboro works of the Canadian General Electric Company, in 1893, serving three years in the works and on the construction staff. He then established an electrical repair shop in Winnipeg with the object of thoroughly investigating the field for such a business, but the prospects for expansion not being, at that time, sufficiently promising, he returned to the Canadian General Electric Company in 1897, first on the engineering staff and about two years later joining the sales organization at Toronto. The following year he was transferred to the Montreal office as assistant district manager, continuing in that position until April of this year, when he joined the sales organization of Allis-Chalmers-Bullock, as assistant d strict manager for Montreal, resigning to form the partnership agreement already mentioned.

Messrs. Stinson and Bell have also organized the Ground Anchor Company, Limited, in which they have a large interest and whose products will be handled by them in addition to those of the Packard Electric Company.

TESTS OF PUMPING PLANT.

In view of the high efficiency reached by the new pumping plant installed for the City of Montreal on McTavish street, the report of the recent official 24 hour test will be found of interest. The plant consists of a 14 inch 3-stage Worthington centrifugal pump built by the John McDougall Caledonian Iron Works Company, direct connected to a 400 h.p. induction motor built by Allis-Chalmers-Bullock, Limited. The test was conducted by Mr. George Janin, Superintendent of the Waterworks Department, and Prof. L. A. Herdt, of McGill University, who reported as follows :—

"As the test was to be made in conformity with clause 9 of the contract, on the capacity of the said pump, which was to be five million imperial gallons per 24 hours against 110 lbs. pressure, this condition was amply fulfilled, the total number of gallons pumped being 5,470,000. The said clause also specified that the test should show that the temperature of the motor working under a full load for at least 12 hours should not be more than 49 degrees C. above the temperature of the room. The results on this test showed that the temperature never rose beyond 30 degrees C. above the temperature of the room.

"In accordance with clause 10, the ordinary working of the pump and motor was not to cause any notable noise or vibration. During the test, as also during the trials preceding the test, this condition was perfectly fulfilled.

"Clause 2. specified that the pump was to attain an overall efficiency of not less than 63 per cent. The test showed that during normal working, that is to say, with a discharge of five million imperial gallons per 24 hours, this efficiency was attained, and during the period when five and three-quarter million gallons were being pumped, an efficiency as high as 67 per cent. was attained."

The committee was well pleased with the report and it was decided to make the first payment on the plant.

A company known as Penmans, Limited, was recently incorporated by the Dominion Government, with a capital stock of $4,000,000 and head office in Montreal. The powers given to the company include the right to acquire and develop water powers for the purpose of generating electric power. The incorporators include Messrs. T.C. Casgrain and V. E. Mitchell, advocate, of Montreal.

The new electric plant installed by the corporation of Napanee, Ont., was put in successful operation last month. The generators, which were furnished by Allis-Chalmers-Bullock, Limited, of Montreal, have a capacity of 125 k. w. at 2,300 volts. They are belted to high speed condensing Corliss engines of 150 h.p., 150 r. p. m., furnished by the Robb Engineering Company, of Amherst, N. S., who also suppl ed the boilers. Two switchboard panels were furnished by Allis-Chalmers-Bullock, while the two panels and regulators for controlling the arc lights were supplied by the R. E. T. Pringle Company, of Montreal. The plant has from the first run very satisfactorily and is a credit to the companies who furnished the equipment and the towns consulting engineer, Mr. R. S. Kelsch, of Montreal.

WESTERN CANADA

ELECTRICAL INSTALLATIONS IN WINNIPEG.

The following is the annual report of the City of Winnipeg Electrical Department for the fiscal year ending April 30th, 1905-1906, as submitted by Mr. F. A. Cambridge, City Electrician :

To the Fire, Water and Light Committee, City of Winnipeg :

GENTLEMEN,—The past year has been a successful one from an operating standpoint. A reduction in cost of street lighting has been reached, the service still further improved and remuneration of employees increased.

Fewer interruptions of service on fire alarm system are again recorded through closer regulation of housemovers.

Better results in regulation of use of electric current have been brought about by the system of final inspections before turning on current.

The increasing amount of work under charge of the Department is evidenced by the fact that the sum of $16,679.60 was expended on labor alone, $1969.66 of which was on work for other departments of this city.

The amount of work in sight for the present year leads me to bring to your notice the most urgent need of adequate facilities for storage of material and for repair shop space. At present we have material and apparatus stored at no less than six different points, which is not a business arrangement but one that occasions much loss of time and material.

INSPECTION OF WIRING.

You will gather from the tabulation given below that a very large amount of interior wiring and apparatus has been installed during the year. On the whole, the City's regulations respecting the installation and use of current have been fairly well adhered to. There is still, however, a considerable amount of interference with electric wires and appliances by incompetent parties, consisting mostly of alterations and additions made surreptitiously. It is frequently impossible to obtain information as to the identity of the offender and the owner is therefore put to the expense of remedying the defects.

A very large amount of overhead wiring has been erected by the Winnipeg Electric Street Railway Company and the City. The consequent increase in the number of overhead wires is very considerable. As I have pointed out on several occasions to the Committee, the dangers from this source are constantly increasing and have already resulted in accidents that point to the very great necessity of the city taking immediate steps to compel the removal of all wires in the congested business district.

The Bell Telephone Company have extended their underground system very materially and have also placed under way the replacing of a considerable portion of their present aerial open wiring by aerial cable, thus greatly improving the conditions as to safety.

In addition to the question of removal of overhead wires as above mentioned, there is very great need for some comprehensive regulations governing the erection and use of both poles and wires. At present there are practically no regulations beyond those contained in certain agreements between the city and various companies that are, properly speaking, defunct. Even though these agreements were adhered to by the operators, they are wholly inadequate to deal with conditions now existing and which were not perhaps contemplated years ago when these agreements were entered into.

RECORD OF INSPECTION FROM MAY 1ST, 1905, TO APRIL 30TH, 1906.

Permits for wiring, 3,691 ; permits for use of current, 3,026 ; arc lamps installed, 304 ; H. P. motors and dynamos installed, 2,918 ; outlets wired, 47,193 ; incandescent lamps installed, 44,875.

For the previous twelve months ending December 31st, 1904, the records show :

Permits for wiring 1905; arc lamps installed, 85 ; H. P. motors and dynamos installed, 1,808 ; outlets wired, 28,316.

Previous to 1905 there was no systematic second inspection before current was turned on, hence the omission of comparative figures in some instances.

FIRE ALARM SYSTEM.

Ten additional fire alarm boxes were installed during the year, making a total of 126. There are also connected to the system 36 auxiliary boxes ; two additional box circuits have been erected, but the final connections have not as yet been made owing to the non-arrival of the Gamewell Manual Repeater purchased some months ago. When this istrument is placed in service the city will have a thoroughly up-to-date system except in respect to overhead wires and style of key boxes.

The number of alarms received during the year were as follows :—

Box alarms	255
Telephone alarms	374
Total alarms	629

The service has at times been interrupted by reason of the wires being exposed to all kinds of interference. The currents carried in these circuits are very small and the instruments connected to them delicate, so that the least interference is often sufficient to disable a considerable number of boxes.

I again strongly urge that some provision be made to place these most important wires underground in the business district. A conduit should be laid on Main street from Graham to Higgins at least, so that the above wires and the police patrol wires could be placed underground before that street is repaved. The revenue from operating private systems might possibly be used for this purpose. However advisable a general conduit system may be, I feel that these wires should be protected immediately. As an instance of the protection afforded by conduits, I may cite Baltimore, where during the recent great fire not one

circuit was disabled. The boxes were destroyed but the circuits were uninjured.

ELECTRIC LIGHTING SYSTEM.

During the past year the street lighting system was extended by the installation of 93 additional street arc lamps and three 50-c.p. incandescent street lamps, making the total number of lamps in service 440 arcs and 24 50-c.p. incandescents. The latter have proved very satisfactory and are suitable for use in many places. In addition Main street subway is lighted by 42 16-c.p. incandescent lamps.

The street lighting service was extended to Ward 7 (Elmwood) and a limited service given on April 14. The balance of the lamp locations are awaiting arrival of new lamps from the manufacturers.

During the year we also installed two additional 50-light Westinghouse constant current regulators; two new circuits were erected for the same, making a total of ten circuits on which are now erected 107 miles of wire.

The only extension on the incandescent system was the connecting up of the Carnegie Library and Board of Works repair shops.

The distribution of street lamps as per ward division as at April 30, 1906, is at follows :—

Wards	1	2	3	4	5	6	7
Arc Lamps	60	71	67	92	97	57	6
50 C.P. Inc			24				
Total	60	71	91	92	97	57	6

The present power house at McPhillip street is now inconveniently crowded, and as we require a largely increased space for our apparatus I trust that my recommendations as to a down-town distributing station will be favorably acted upon.

GENERAL WORK.

A large amount of electrical work was performed for various civic departments, such as building power lines for Board of Works and Water Works; installing electric fixtures in Carnegie Library; investigation as to electrolysis; illumination of City Hall; lighting and telephone service installed at new wells and other buildings. The electric lighting service at last year's Industrial Exhibition was also under the care of your electrician.

I have on various occasions through the year pointed out the necessity of dealing with the matter of electrolysis and also while in the East investigated the matter as affecting other cities. Our inspection of the track return system of the local street railway has shown same to be insufficient and very poorly maintained, to which fact may be attributed nine-tenths of the damage.

The increasing number of suburban electric railway lines all operated by direct current from the Winnipeg plant and returning their current through the earth is the latest menace to the underground pipe systems.

City of Winnipeg Electric Light System.

Schedule of operation.	Moonlight Schedule.	All Night Schedule.
Hours of operation of arc plant....	3,003H.45M.	3,715H.25M.
Hours of operation of inc. plant...		4,562H.00M.
Average arc lamps in service ...	305	90
Maximum arc lamps in service....	314	135
50 c.p. series inc. lamps..........	24	
Total arc lamp hrs. (less lamps out)	925,833	307,844

Cost of Operation 1905-06.	Moonlight Schedule.	All Night Schedule.
Cost per arc lamp per hour.............	$00.0247	$00.0247
" " night	00.2053	00.2537
" " year.........	75.65	91.88

Comparison with Previous Years.

Cost per lamp per night 1904-06.	.2097
" " 1903-04	.2395
" " 1902-03.	.2397
Construction expenditure, 1905-06..................	$16,112 95
Operation " "	$38,176.01

City of Winnipeg Fire Alarm System.

Construction expenditure, 1905-06..................	$ 3,692.86
Operation " "	3,300.99
Revenue from operating private systems...........	755.00
Net cost operation, 1905-06................	2,545.99

Statement of Cost of Electric Lighting, 1905-1906.

Power House.	Arc.	Inc.	Total.
Fuel..........................	$11,007.49	$2,912.91	$13,920.40
Firing, maintenance, boilers, plant, etc.	2,264.72	602.00	2,866.72
Oil, waste and supplies......	410.89	109.22	520.11
Engineers' wages............	1,913.54	508.66	2,422.20
Maintenance electric plant....	324.30	1.09	325.39
Maintenance steam plant....	345.17	91.75	436.9-
Rental of buildings at power house	1,593.54	423.60	2,017.14
Rental of generator	518.18	137.75	665.93
Tools and plant	65.60	17.44	83.04
Outside System.			
Trimming	3,273.74		3,273.74
Carbons and globes (open arc)	2,787.31		2,787.31
Carbons and globes (enc. arc)	537.94		537.94
Lamp repairs and testing....	808.11		808.11
Maintenance of outside lines..	1,913.11	136.11	2,049.22
Miscellaneous.			
Office expense & Management	1,657.10	440.50	2,097.60
Interest on bonds............	1,745.54	354.46	2,100.00
Sinking fund.	748.29	151.71	900.00
Insurance	65.00	9 30	74.30
Incandescent lamp renewals..	18.57	281.37	299.94
	$31,998.14	$6,177.87	$38,176.01
Add subway lighting	367.24		
Subtract subway lighting.....		367.24	
Cost street lighting..........	32,350.94		
Cost lighting city buildings..		5,825.07	

Statement of Incandescent Lamps in Civic Buildings.

No. 1 Fire Hall....	73 lights.
" 2 "	50 "
" 3 "	43 "
" 4 "	31 "
" 5 "	28 "
" 6 "	32 "
" 7 "	31 "
Fire Alarm Office........................	10 "
City Market Building.....	74 "
Weigh Scales...........................	4 "
Carnegie Library..	246 "
Police Station..............	65 "
Crematory........	9 "
City Hall......................	369 "
Water Works Building No. 1..............	71 "
" " No. 2........	13 "
Softening Plant..........................	38 "
Water Works Store House.......	29 "
" Stables	4 "
Board of Works Store House..............	42 "
" Stables.	11 "
" Repair Shops	6 "
" Cement Sheds . . .	20 "
Electric Light Engine Room.	15 "
Total	1,314

The above statement is made out on the basis of 16 c.p. lamps connected or their equivalent.

City of Winnipeg Electrical Department.

Statement of interior electrical inspection work for three months ending July 31st, 1906.

Month	Permits for wiring	Permits for use of current.	Interior arc lamps installed.	H.P. Motors installed	Outlets wired	Inc. lamps installed
May..	365	228	2	164	3878	2337
June	408	283	1	165	5397	3006
July..	447	297	14	410	6652	3776
Total...	1220	808	17	739	15927	9119
Previous 3 months	570	522	16	384	11700	12255

I beg to cordially thank the members of the Committee and Council for their interest and appreciation, and to the employees of the department I am indebted for duties cheerfully and faithfully performed.

F. A. Cambridge,
City Electrician.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUESTION NO. 1.—Will you kindly explain the use of the atmospheric relief valve and tell me at what point of the piping this is mostly used.

ANSWER.—The atmospheric relief valve is an automatic device for providing a free opening to the atmosphere in connection with condensing engines, should through any cause the condenser lose its vacuum. This valve is placed on a branch in the exhaust pipe running between the engine and the condenser, and it acts in every sense as an ordinary check valve, being held tightly closed by the pressure of the atmosphere, while the condenser is maintaining its vacuum, but opening and providing a free exit for the steam should the vacuum drop. Condensing engines are often piped without an automatic relief valve, but this, to say the least, is extremely poor practice. When such an arrangement is adopted, and the condenser drops its vacuum, the steam pressure accumulates in the exhaust pipe until it is sufficient to blow through the condenser and exhaust through the pipe which normally carries off the water and air. This action, when it takes place, is very liable to injure the valves of the condenser, and the back pressure placed upon the engine has a serious effect upon the latter's speed and capacity. Therefore, in every case, a free exhaust to the atmosphere should be provided, and a valve included in the piping which can be depended upon to open readily in case of anything going wrong. These valves differ materially from an ordinary check valve inasmuch as a dash pot is incorporated in their makeup, thus giving the disk a smooth action. Were it not for this dash pot, the valve would pound on the seat, and it would be doubtful if it could be maintained tight. Valves of the vertical type will of course be water-sealed, and this aids materially in the maintenance of the vacuum. Horizontal valves, however, have to be provided with a special construction in order to be water-sealing, this arrangement simply being a raised edge around the valve seat, which forms a cup and holds a certain amount of water over the contact between the disk and the seat itself. Automatic relief valves should be provided with an arrangement whereby the disk can be held permanently away from the seat, this device being used where it is necessary to exhaust the engine free to the atmosphere for any period of time. Sometimes such devices are permanently attached to the disk, so that same may be either held open or pressed against the seat. This arrangement has often been found convenient in getting the vacuum back on an engine which has lost it, the disk being pressed downward while the valve leading to the condenser is being opened. The arrangement should not be necessary with a valve which acts freely, but from our own experience in such matters, we may say that in several instances a device which would assist in the closing of the valve has been found of particular value.

QUESTION NO. 2.—Will you kindly advise me through your columns, why in a three-phase, three-wire system, I get 107 volts between the centre and each outside wire, and only 105 volts between the two outside wires? In a three-phase, three-wire, sixty cycle system, there are a greater number of transformers connected across the primary mains in one phase than the other; what will be the effect upon the alternator or system? In the secondary distribution of the above system, with three supply wires, must there be an equal number of lamps connected across from the centre wire to each of the outside wires, and also across the two outside wires, or how must, say, thirty lamps be divided up?

ANSWER.—We think you have answered your first question by your second. Evidently you have a greater number of transformers connected across each of two phases than connected across the third, and hence the voltage across the lightly loaded phase is higher than that across either of the other two phases. If your load is not balanced the phase with the greatest load will have a slightly lower voltage than the others, and in the same way the phase with the lighest load will have the highest voltage. Your third question is not quite clear, as we do not know whether you have a three-wire secondary distribution with 220 volts across the outside wires and 110 between the centre and each outside, or whether you mean by "three supply wires" that you have your secondary system wired up on precisely the same scheme as the primary, which, to say the least, would be an unlikely arrangement. Possibly the following explanation of division of load on a three-phase system will be of assistance to you. Three primary lines called A, B and C, run from the power house to the point where the current is to be used, the voltage between each wire being 2080. Across wires A and B we place a transformer reducing to a secondary voltage of 104, and across these secondary wires we connect ten 16 c.p. lamps. Across wires B and C, possibly at some other point in the town, a transformer of the same size is connected and a similar number of lamps wired up on its secondary. Then at some other point a similar transformer with a similar number of lamps is connected across wires A and C. If all lamps are burning at the same time, the load on each phase of the generator will be perfectly balanced, and if the generator windings are correct, the voltage across each phase will be identical. In place of the secondary arrangement as outlined above, namely, two wires with 104 volts, you could use three-wire secondaries with 104 volts between the centre and each outside, and 208 between the outsides. The ten lamps previously mentioned would, where such an arrangement is used, be connected five between the centre and one outside, and five between the centre and the other outside. The load on the transformer would thus be precisely the same as if a two-wire secondary system were used. Any one or more of the above mentioned three transformers could be connected with two or three wire secondaries irrespective of whether the other transformer or transformers were so connected, without affecting the balance of the system.

A UNIQUE ELECTRIC PLANT.

A somewhat unique electric lighting plant is now in operation at the town of Kenora, Ont., a town situated on the Lake of the Woods about 130 miles east of Winnipeg. The town authorities are making an extensive power development on the falls of the Winnipeg river at the rear of the bridge shown in the illustration. This called for the removal of the old lighting plant, as extensive blasting operations are being carried out on its former site. Kenora and also the adjoining village of Norman and the town of Keewatin are at present lighted from temporary plants, one of which is located in a saw mill to the right of the illustration but not shown; the other is located on an old side-wheeler, the "Monarch". This vessel was partially destroyed by fire some time ago but is now patched up and moored alongside the bank of the lake. A horizontal engine was secured and connected to the boat's boilers and belted to a 1500 light 2000 volt single-phase Canadian General Electric Company's generator. The wiring is run to a temporary switchboard and thence out from the boat to the bridge and to the pole line. The appearance of the charred and

Unique Electric Plant at Kenora, Ont.

partially dismantled steamer is highly interesting and one would hardly expect to find within it a plant of the above description operating night after night under such conditions.

ANNUAL MEETING OF ALLIS-CHALMERS-BULLOCK.

Taking the tide at the flood, Allis-Chalmers-Bullock, Limited, of Montreal, have decided to provide ample manufacturing facilities to meet the demand for hydro-electric plants. The shareholders at the annual meeting last month decided to increase the capital stock from $1,200,000 to $2,500,000, and part of it will be used for this purpose.

It is the policy of the directors to make the company more than the selling agents for the well known products of the allied companies, Allis-Chalmers Company, Milwaukee, Wis., Bullock Electric Manufacturing Company, Cincinnati, Ohio, Ingersoll-Sergeant Drill Company, New York, and Lidgerwood Manufacturing Company, New York.

The reports showed that the business done during the past year had more than doubled; that there are now 600 men at work as compared with 300 a year ago, and that, though the shops have been working night and day since the beginning of the year, the amount of orders unfilled is over three times larger than a year ago. The company has been taking up from time to time the manufacture of those lines best warranted by the condition of the markets. It will now go thoroughly into the development of another important line, the Christensen air brake.

Over 80 per cent. of all electric railway cars using power brakes of any description are claimed to be equipped with the Christensen air brake, and there are over 16,000 of them in use throughout the world on over 350 different electric railways. Allis-Chalmers-Bullock, Limited, has the exclusive right to manufacture the Chtistensen air brake in Canada.

The following directors were elected at the meeting: Messrs. Edgar McDougall, W. C. McIntyre, J. W. Pyke, Phelps Johnson, Wm. McMaster, H. J. Fuller, Alex. Pringle and J. A. Milne, of Montreal; W. H. Whiteside and Chas. Allis, of Milwaukee; George Bullock and J. S. Neave, of Cincinnati; E. D. Adams and W. W. Nichols, of New York; and Lloyd Harris, of Brantford. Subsequently Mr. George Bullock was elected president and Mr. Edgar McDougall vice-president of the company and chairman of the executive. The directors have had under consideration for some time plans for enlarging the buildings and increasing the equipment, and with this increased capital they will be able to go ahead with the contracts for these purposes.

SNOW MELTING MACHINE.

A test was recently made by the city fathers of Montreal of a snow melting machine. The machine is an apparatus of box form with two burners, each burner carrying a series of gas jets. The gas is let into these jets along with air under pressure. The casing of the machine is of wrought iron plate, built on a wrought iron frame with door arranged as to give access to the working parts of the machine for the purpose of cleaning and overhauling. The water is let off by two conductors or gutters on either side of the melting plate. The doors of the openings are thrown open at the top so as to give access to the snow or ice being thrown in on to the melting plate. The general outline of the machine is box shaped, and it is mounted preferably on a sleigh, having attached immediately below the casing four small runners for the proper adjustment of the apparatus.

The test was made with crushed ice. There were two on either side of the machine, each containing 550 pounds of crushed ice, which the inventor guaranteed to melt in seven minutes. The test, however, extended over fifteen minutes, at the end of which time the machine had melted 616 pounds of ice, leaving a balance of 484 pounds. The computed figures, from actual notes taken, were 900 pounds of ice melted in fifteen minutes, but the inventor, who supplied these figures, included in them the weight of the box in which the crushed ice was measured into the machine, and on deducting the weight of that from the total of 900 pounds it was found that the actual weight of crushed ice was 616 pounds melted, leaving a balance of 116 lbs. inside the apparatus, when the gas was turned off.

Civic officials who were present were not convinced that the machine would not solve the problem of snow removal in Montreal.

The Hamilton Terminal Company are asking for tenders for a new terminal station. The designs were prepared by Charles Mills, architect.

BELT ENGINEERING

By John Tullis.

Prime movers may be said to form the foundation of the subject of belt engineering, and pulleys consequently have the first claim for consideration. All pulleys should be turned with the convexity true to the centre, and care should be taken, while turning the pulley, to see that no shoulder is left on either side of the centre of the convexity. A testing template should be used while the work is being done, to see that the convexity rises on a true line of increase of diameter from the sides of the pulley to the centre. A caliper of narrow steel tape should be passed round the various parts of the pulley before saying it is finished. This little trouble will turn out perfect work, which will save much worry afterwards. I have had experience with belts running on pulleys having an invisible shoulder which took charge of important belts. Whenever the belt became the least slack this shoulder took charge of the belt to such an extent that it removed it 5 in. away from the convexity, and held it there all the time, no matter how slack it became. To bring the belt back to the centre of the pulley it had to be shortened, which process strained the belt and would soon have destroyed it. In due time the belt stretched a little again, and by degrees it followed the call of the higher side, which took charge of the belt once more and kept it to itself. But when the pulley was turned true the drive became a splendid success.

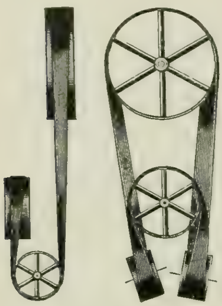

Fig 1.

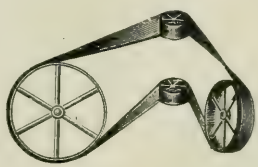

Fig. 2.

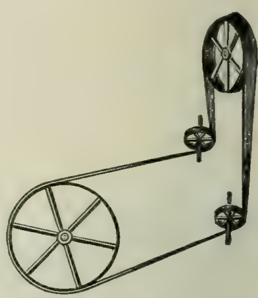

Fig. 3.

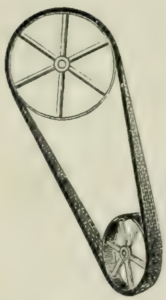

Fig. 4.

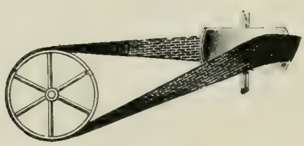

Fig. 5.

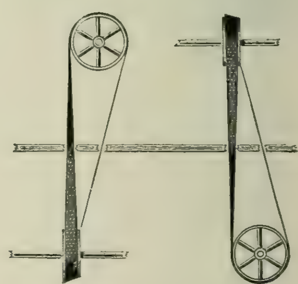

Fig. 6.

Most pulleys of large diameters need have no higher a convexity than 5-32 in., no matter whether it be 10 in. or 10 feet wide. The pulley of a smaller diameter should be flatter on the face than the larger pulley. The master pulley will always hold the belt at its work, even though the smaller pulley be nearly flat. I do not recommend the smaller pulley to have a higher convexity than 1-16th of an inch. Under these conditions every horse-power can be got out of the belt that is in it. I have seen much loss and serious trouble arising from high convexity. I have met pulleys with a convexity of from 3/8 in. to 1 in. No belt can take charge of its work when run on pulleys of such form, because the centre of the pulley goes through more air space than the sides do, and the leverage over the centre causes the sides of the belt to lift from the work; in fact, the sides of the belt cannot get a chance of lifting any of the load at all. The higher the speed of pulley travel the greater is the loss of power. When much power is taken through pulleys of this make the belt refuses to lift the load, and it slips back, while the higher speed of the pulleys soon destroys the working face of the belt, because it becomes burned and hardened through friction. Stretch is blamed for the trouble, the belt becomes torn to pieces because it is often shortened, the disease being misunderstood. I have had many high convexities turned down at holiday time while the pulleys were in their place, and have removed tons of worse than useless cast iron. This simple plan overcame all the trouble. The drives are now perfection, while the odd belts are now easy masters of the work and will run for many years.

COMBINATION PULLEYS.

I have also had considerable experience with two, thee, and four narrow pulleys, hung alongside each

other, to make room for a wide driving belt. One important drive was in a tunnel, where one wide pulley could not be engineered into the space. Four 12-in. pulleys were turned up separately. Each had a low convexity; yet when the pulleys were fitted on the shaft the wide flat belt could not get a grip of the power required. Had this combination been turned

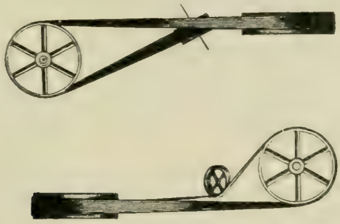

Fig. 7.

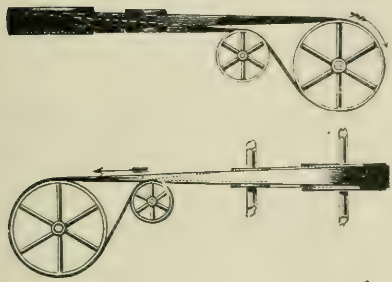

Fig. 8.

up in the form of one pulley, all would have gone well. Through pressure of work part of the machinery was run while a link belt was made to the form of these pulleys, having three flexible centres. This belt went off with the load at once. I have met with many cases of this class. When pulleys and belts are true to each other the drive can be made perfection; yet it is only courting disaster to run belts on combination pulleys without turning the face of these to the form of one pulley.

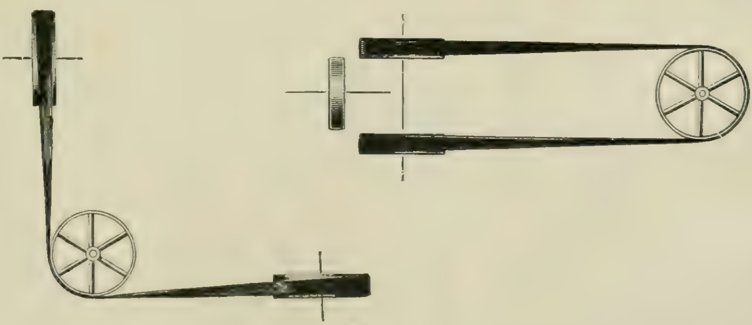

Fig. 10.

COMPOUND PULLEYS.

By these I mean hanging two or three pulleys alongside one another on one shaft, while connecting them with another set of pulleys, hung upon another shaft, by two or three independent belts. It is hardly possible to make the various belts the same length, while the pulleys may vary a little in diameter, with the result that the belts do not travel in unison.

The tight belt will get the largest share of the power to carry while dragging the slack belt along with it. The loss of power here is considerable. By simply compounding these belts, the one on the top of the other, on one driver and driven pulley, three belts will return fully three times the power of belts running alongside each other like ropes, which also pull the one against the other.

IDLER PULLEYS.

This system of increasing power has been coming much into use of late years, with the idea of getting more power by putting more of the driving face of the belt in contact with the face of the pulley. This is a

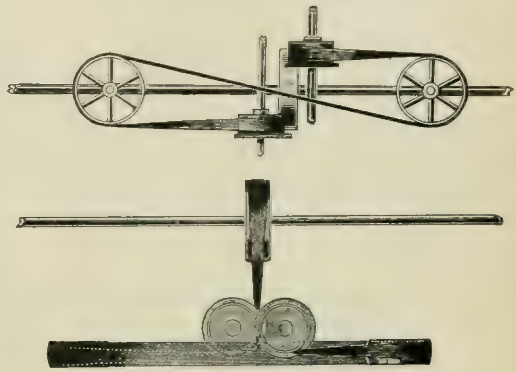

Fig. 9.

very severe system of getting an increase of power, and it is also a killing system for the belt. When the idler presses on the slack side it is not so bad on the belt, but when the idler presses on the tight side of the belt the strain is enormous, often ten times greater than it should be. The portion of the belt between the face of the idler and the face of the pulleys is so short and so tight that the belt is soon strained to death. The felting of the fibres of the leather soon becomes broken up by so much bending up and down that it becomes useless, like the bending up and down of a tough metal wire or hoop. The drag of the idler upon the prime mover causes much waste of power and grinding of shafts and bushes, producing a large bill for lubrication while making a mess of the surroundings from waste oil. Without thinking much about the belt, architects and many electrical engineers like this mode of driving because it looks compact and takes up a little less room than does an open free drive by belts. Compound belts give splendid results when running on short centres. Of course a long belt has

a better chance of living to a respectable age than a short one, because the parts of the short belt return so often to lift the load that it becomes weary and worn much earlier in life than the long belt. When room is a consideration the same good results can be got by compounding two, three or four short belts, the one on top of the other. Each belt does its own share of lifting the load, and the constant division of labor gives as good a drive as long centres will give.

COMPOUND BELT-DRIVING.

This class of drive has become a new power, while filling in a much-felt want. There is no need now for pulleys of great width, which take up much valuable room while costing a considerable amount of money. Three 20-in. belts, working compound, will transmit more power than one 60-in. belt will transmit. With a wide belt there is always, between the belt and the pulley, a cushion of air, which causes slip ; but with the narrower belts this air can find little lodgement, because the narrower face gets rid of it much quicker from compression. Some engineers and scientific electricians say that this mode of driving can give no increase of power, because the outer belts have no pulley contact. They do not require pulley contact. All they need is a chance of running each one for itself, one on top of the other ; then the system will soon prove that they are masters of the power, while passing their influence through each other to the pulley. Unless No. 1 is overloaded with work, it should run about as fast as the pulleys, but if it be out of condition or overloaded, it will slip back from the load somewhat when struggling to lift it. Each belt has a travelling speed of its own. The outer belts cover a larger circumference than do the inner belts. No. 2 will run many feet faster per minute than No. 1 does, and this gain is according to increase of diameter and belt speed, while No. 3 and No. 4 will each do a large share of the work. These outer belts are more powerful than the inner belts, because they are running on leather pulleys, while each gains in speed upon the lower belt, thereby preventing slip. There are hundreds of compound belts doing grand work all over

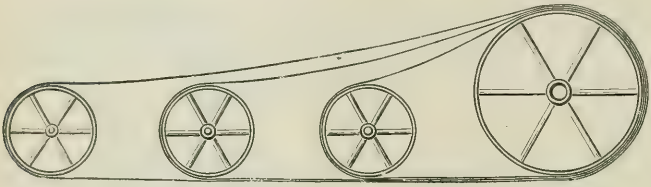

Fig. 11.

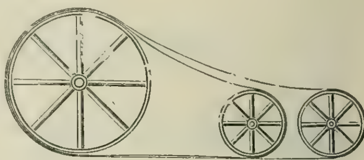

Fig. 13.

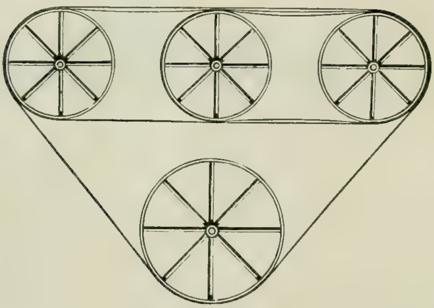

Fig. 12.

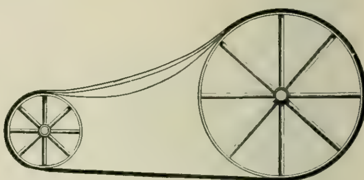

Fig. 14.

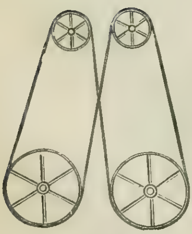

Fig. 15.

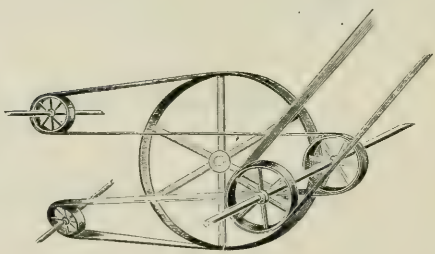

Fig. 16.

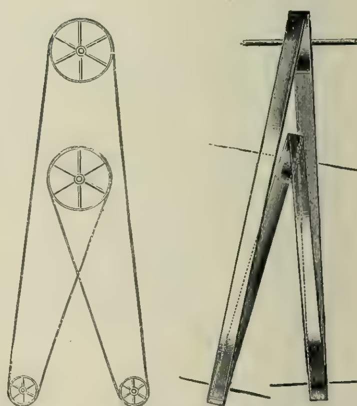

Fig. 17.

the country, and there are also many examples of triple compounds running, while there is one example where four single 16-in. belts have been working splendidly for years where a mechanical mistake was made in the design of the plant. A 12-ply 16-in. rubber belt only lasted a few months while it was ground away by slipping friction. In this case there was no room to increase the size of the pulleys or increase the speed, and I merely mention this drive to show how handy compounding comes in where power is wanted, while no expensive alterations need be thought about.

FLEXIBLE CENTRE-LINK BELTS.

These, when made concave to the form of the pulleys, make a most powerful driver. When running at speed over 1,800 per minute this class of belt will transmit 25 per cent. more power than a flat belt will

transmit. Every inch of its face is put in contact with the face of the pulley. No cushions of air remain between the pulley and the face of a link belt; while centrifugal force has no effect upon this belt, no matter how high the speed may be, because the whole belt is an equalized mass of leather hinges.

LAMINATED BELTING.

When this belt is made concave to the form of the pulley, it is a most trustworthy and powerful transmitter of power if run on pulleys over 3-ft. diameter. If this belt be run on smaller diameters it life is by no which gave no end of trouble. The belt drew up in the centre like a bridge, because it tried to climb the greater diameter of the cones. Only about 2 in. of each side of the belt had pulley contact. The strain was so severe that the belt began to give way on each of the sides. Many kinds of belt were tried in this case, yet the difficulty was only met by compounding three 3½-in. single belts. The narrow belts do not feel the influence of the cone to any degree, while the compound pressure keeps each belt at its work. These belts have been running years now, while the machine

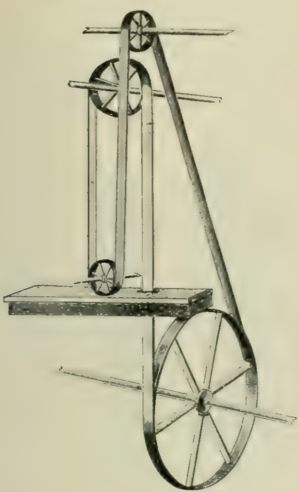

Fig. 18.

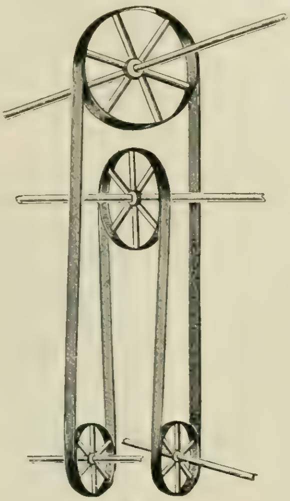

Fig. 19.

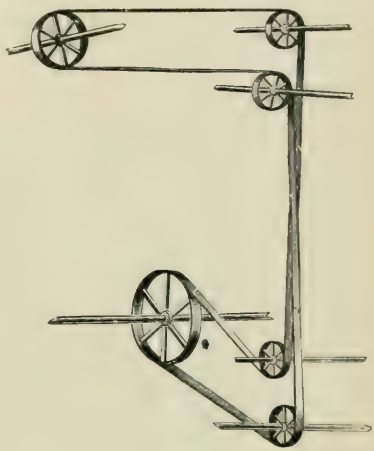

Fig. 20.

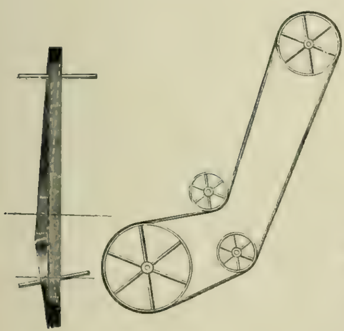

Fig. 21.

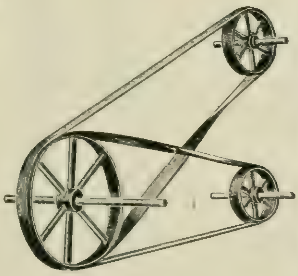

Fig. 22.

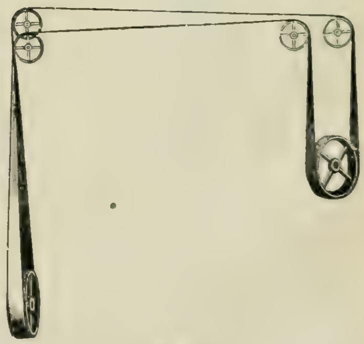

Fig. 23.

means long, as the side next the pulley soon becomes broken up from compression. Small wrinkles are formed on the inside, and these become cut by running friction to such an extent that the belt begins to show open cracks, which lead to an early breakup of this rather expensive article.

TAPERED CONE BELT.

A very satisfactory way of getting power through tapered cones is to use tapered link belting. The taper on the belt is made the same as the taper on the cone. By bringing the thick side of the belt in contact with the smaller diameter of the cone the drive is the same as is the belt were running on a flat pulley. Another good way of meeting the difficulty connected with cone driving is to run two, three or four narrow single belts compound. I saw an 8-in. single (sent along with a high-class machine) having a taper cone drive is doing the work it was designed for with ease and comfort.

QUARTER TWIST BELTS.

The best class of belt for this mode of driving is to use belts made with a long side to suit the diameter of the pulleys. The only cause of trouble here is the fact that attendants sometimes fix up the belt with the long side where the short side should be, with the result that the belt soon bursts across.

EXPLANATION OF FIGURES.

Fig. 1 shows a flat belt transmitting power between two parallel shafts over guide pulleys, the shafts not being on the same plane.

Fig. 2. This is an illustration of a flat belt transmitting power over guide pulleys to shafts, not parallel but on the same plane.

Fig. 3. In this sketch a flat belt is shown transmitting power over guide pulleys, the shafts being neither parallel nor in the same plane.

Fig. 4. A patent thick-sided leather link belt working quarter-twist, and transmitting power between two shafts, which are not parallel. No guide pulleys are required in this drive.

Fig. 5 shows a belt similar to the foregoing, but transmitting power between two right-angled shafts without guide pulleys.

Fig. 6. In this illustration a patent thick-sided quarter-twist leather link belt is shown transmitting power between two right-angled shafts. No guide pulleys are necessary.

Fig. 7. Here is a flat quarter-twist belt showing power transmitting between two right-angled shafts, with leading guide pulleys to remove the twist from the belt before delivering it to the driven pulley.

Fig. 8. This quarter-twist belt is in all respects the same as that shown in Fig. 7, but having in addition a tightening pulley, by means of which the belt can be put into or out of driving contact at pleasure.

Fig. 9 is an illustration of a method of transmitting power with a flat belt from one main shaft to two counter shafts running at right-angles.

Fig. 10. A general method of transmitting power by belt to shafts running at right-angles is shown in this figure.

Fig 11 shows a method of transmitting power from one main driving pulley to two, three or more driven pulleys in direct line. This plan saves space and works well.

Fig. 12 shows mode of connecting three driven shafts to main drive by compounding belts. Each shaft has a driving belt of its own. The main belt runs on the top of those that are driven.

Figs. 13 and 14 show examples where a single engine is compounded and the engine power doubled. All the power of the compound engines can be got through compound belt driving without the expense of altering foundations or increasing the width of the face of the main driving pulley.

Figs. 15, 16 and 17. These illustrate modes of transmitting power by flat belt, directed by guide pulleys, from one shaft to another, in cases where the shafts are much too near each other for direct driving. The shafts may or may not be parallel.

Fig. 18. Illustration of a method of driving right-angled shafts with a flat belt over guide pulleys, so arranged that the strain is equalized throughout the belt.

Fig. 19. A method of transmitting power between two right-angled shafts working as near to each other as the pulleys will allow, and with the guide pulleys so arranged as to distribute the tension equally throughout the width of the belt.

Fig. 20 shows a method of transmitting power to two shafts set at right-angles, the strain being equalized by means of four guide pulleys.

Fig. 21. In this illustration we have an example of the transmission of power between two buildings which are not parallel with each other. By properly adjusting the guide pulleys the belt may be made to drive shafts parallel to each building.

Fig. 22. This illustration shows a method by which two shafts can be driven by one belt from one driving pulley, by making a twist upon the two portions of the belt that come together. The belt is made to clear itself. The drive is then the same as if it were an ordinary cross belt.

Figs. 23 and 24. These illustrations show an easy plan of connecting shafts by belt where the wings of a factory are built to obtuse angles. The shafts will be driven parallel to each building.

Fig. 25 shows method of transmitting heavy main driving power to the shaft set at right-angles.—From Public Works.

Fig. 24.

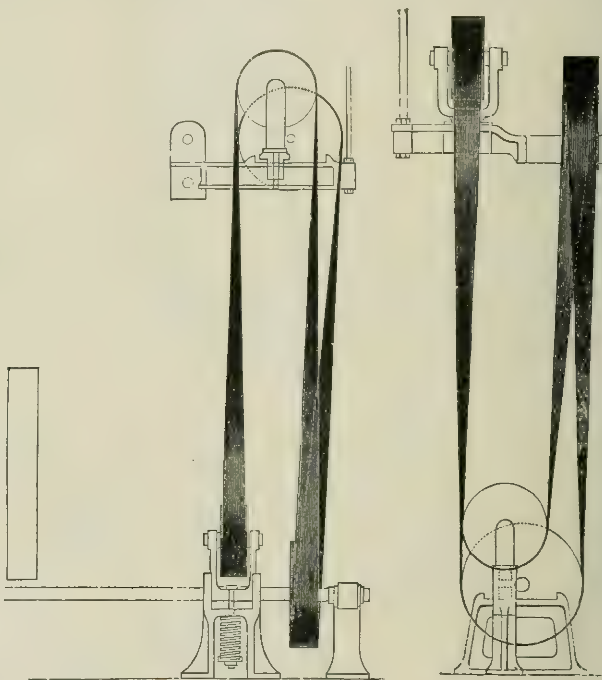

Fig. 25.

LADY DESIGNER OF ELECTRICAL APPARATUS.

We are indebted to the Technical World Magazine for the information that in the Pittsburg workshops of the Westinghouse Electric & Manufacturing Company there was until recently a lady who every day did engineering work of a high order, making the designs for direct-current electric generators and motors. This woman began her work as Miss Bertha Avanella Lamme. She is now married to a fellow-engineer, Mr. R. S. Feicht. Mr. Feicht designs induction motors. His work, therefore, exactly parallels that done by Miss Lamme on direct-current motors, and their union was technically as well as sentimentally appropriate.

Miss Lamme was born in Clark County, Ohio, and is of American parentage. The family consisted of four sisters and two brothers, one of whom—Mr. B. G. Lamme—is the chief engineer of the Westinghouse Company. She was educated in the Ohio State University of Columbus, Ohio, from which she was graduated in 1893 with the degree of Electrical Engineer in Mechanical Engineering. After graduation Miss Lamme was employed in the Power Division of the Engineering Department of the Westinghouse Electric & Manufacturing Company, where she was engaged for several years in designing generators and other electrical apparatus. She is an unusually fine mathematician and achieved great success in the design of electrical machinery, eventually occupying a very high position in the Engineering Department. She was married to Mr. R. S. Feicht, head of the Industrial Division of the Engineering Department, December 14th, 1905.

MRS. R. S. FEICHT,
Who Designed Direct Current Generators and Motors for the Westinghouse Electric & Manufacturing Company.

REDUCING THE COST OF INCANDESCENT LAMPS.

In the beginning of the career of the incandescent electric lamp, about 75c. worth of platinum was used in a single lamp, and the bulb was blown by hand from a piece of tubing. At the present time the platinum in a lamp costs about ½c., and the bulb, which is made in large quantities at the glass factories, cost about 2c. It may appear from this that the present selling price of such lamps—18 cents for the ordinary size—is unnecessarily high; but when it is considered that there are some 50 operations in the process of manufacture, nearly all of which requires special skill, and many of which involve refinements of manipulation, which are nothing less than marvellous, this thought changes to one of wonder that the price can be made so low. Nevertheless, manufacturers are continually seeking to reduce the manufacturing cost, and a saving which would represent one or two-tenths of a cent on a lamp would be well worth considering.

An inventor in Toledo, Ohio, has constructed a machine for blowing the bulbs which is said to reduce the cost to about one-quarter of the present amount. While the name of the inventor is not mentioned, it is very likely the same one who has perfected a bottle blowing machine which is revolutionizing the whole blown glass industry; so that there seems little doubt of his accomplishing similar results in the manufacture of lamp bulbs.

Platinum is more valuable, weight for weight, than gold, and the limited supply is controlled by the Russian government. Innumerable attempts have been made to find some substitute for this expensive metal in the manufacture of incandescent lamps; but while many devices have promised well, none have come into practical use. We understand, however, that Maxim, the noted English inventor, has, after long study and research, succeeded in producing a metal which, when drawn into wire and platinum coated, answers the purpose of solid platinum in every particular. The metal has been tried on a commercial scale in England with apparently satisfactory results.

ELECTRIC POWER AT BRANTFORD.

Notwithstanding the fact that before long Brantford will be enjoying the advantages of transmitted electric power, the Brantford Electric & Operating Company, Limited, appreciating the desirability of having an absolutely reliable source of supply, determined to place their power house in the front rank of the electric power stations in Canada, and have recently made extensive improvements. The feature that strikes one most forcibly on entering the buildings is the solidity and massiveness of the construction. No combustible material is to be seen, concrete and steel being used throughout.

The turbine driven dynamos are of 600 horse power each and have a combined capacity sufficient to supply 16,000 16 c.p. incandescent lamps. On the same floor are the transformers, while below the generator floor are the belt chambers and water wheels, enclosed in pits formed of concrete walls four feet in thickness.

The auxiliary steam plant includes three 400 h. p. boilers equipped with stokers.

In the generating room is installed the largest engine ever turned out by the Waterous Company, also the generators, duplicates of those in the water power station. The engines, boilers, condensers, etc., were supplied by the Waterous Engine Company; the cement was supplied by the Ontario Portland Cement Company of Blue Lake; the wiring and conduits were furnished by the Federal Electric Construction Company, and the buildings and foundations erected by Messrs. P. H. Secord & Son, all local concerns.

The installation of the new plant, which was designed by R. S. Kelsch, E. E., of Montreal, was done under the supervision of Mr. Louis W. Pratt.

TELEGRAPH and TELEPHONE

TELEPHONE EXPANSION.

Since the passage of the act bringing the telephone companies under the control of the Railway Commission, three hundred applications for approval of new lines, extensions, etc., have been disposed of by the Commission and many more are on hand, which indicates a great expansion in the telephone business during the summer months. A great many of the applications are from the west, where telephones have come into general use among the farmers.

NOVEL CABLE-LAYING APPARATUS.

In Berlin, Germany, the telephone wires are formed into cables of large size, and are laid in cement conduits. To carry this out a gang of ten or twelve men is generally needed, so that a labor-saving device could be a great advantage here. This was found in the shape of a vertical drum operated by an electric motor, which is used for drawing the cables through the conduits. To make it easy of transport, the apparatus is installed upon two separate wagons. The first wagon which forms the current-generating plant contains a six-horse-power petrol motor coupled to a small dynamo. On the second and larger wagon we have a three-horse-power motor mounted with the cable drawn. With this apparatus a great saving of time is effected, and in one case a cable of the heaviest type of 600 feet length was drawn through the conduit in seven minutes.

NEW TELEGRAPH SUPERINTENDENT.

Mr. Fred T. Jennings, until recently employed as inspector of C. P. R. telegraphs, has been promoted to the position of superintendent of telegraphs of the Lake Superior district, with headquarters at Sudbury. This division embraces the territory from Chalk River to Fort William, and includes the Soo branches. It has been made a separate division owing to the large increase in business and the consequent additional telegraph lines.

Mr. Jennings began his telegraphic career in 1875 with the Montreal Telegraph Company. In 1880 that company became amalgamated with the Dominion Telegraph Company, now forming the present G. N. W. Telegraph Company. He remained with the latter company until the inauguration of the C. P. R. telegraph system in 1886, when he was made assistant chief operator. In 1890 he was promoted to the position of chief operator and circuit manager, and on the promotion of Mr. Frank Richardson to the office of superintendent of the Eastern division, Mr. Jennings became inspector of lines, east and west.

Mr. Jennings is exceptionally well posted in electrical matters, especially those pertaining to the telegraphic service. He is also one of the best known andmost popular officials in Canada.

Mr. Harry Bott, who is now chief operator in the Montreal office, will succeed Mr. Jennings as inspector of lines. Mr. Frank Mahon, local manager of the Quebec office, will succeed Mr. Bott in the Montreal office, and Mr. Joseph Manning will become local manager of the Quebec office.

SHORT-CIRCUITS.

The Bell Telephone Company have completed the installation of 363 telephones in the Royal Alexandra Hotel, Winnipeg.

Mr. G. Derome, local manager of the Bell Telephone Company at St. Johns, Que., has been transferred to Three Rivers, and will be succeeded by Mr. Macfarlane.

Mr. J. G. McCrae, who died recently at Sarnia, Ont., was in early life a telegraph operator. Mr. T. A. Edison, the inventor, was for a time an apprentice under Mr. McCrae.

Lindsay, Ont., is to have competition in the telephone business, the Town Council having granted a twenty-one year franchise to the Canadian Machine Telephone Company.

The St. Mary's & Medina Telephone Association are now building a telephone line to connect the villages of Kintore, Lakeside, Medina, Wildwood and Harrington with St. Mary's.

The Union Farmers' Telephone Company, Limited, has been incorporated at Langford, Man., for the purpose of constructing a telephone system within the municipality. The capital is $2,000.

The British Columbia Telephone Company contemplate building a new exchange in New Westminster, in which the latest type of switchboard will be installed. Work will not be commenced until the beginning of the year.

The shareholders of the Central Telephone Company, at a meeting at St. John, N.B., September 27th, passed a resolution autnorizing the directors to enter into an amalgamation with the New Brunswick Telephone Company, on the basis of dollar for dollar.

Mr. S. Edwards, who has been appointed assistsant supertindent of C. P. R. telegraphs for the Western division, with headquarters at Calgary, was presented with an address and a purse of $300 by the staff of the telegraph construction department at Winnipeg.

The American Machine Telephone Company, Limited, has been incorporated, with a capital of $450,000 and head office at Brantford, Ont. The provisional directors are Messrs. T. P. Moulden, manufacturer, H. N. Baker, law student, and A. N. Knox, barrister.

The Ingersoll Telephone Company, Ingersoll, Ont., has been organized, with the following officers: President, H. F. Boyse; vice-president, O. E. Robinson; secretary, E. H. Hugill; manager, T. A. Mayberry. Over 300 subscribers have already been secured and the work of installing the system will be commenced at once.

The Bell Telephone Company have awarded contracts for the remodelling and extension of their central office in Ottawa. The exterior includes a 26-foot addition to the rear of the premises, while the front will be brought to the street line. Work will be proceeded with at once. The contracts involve an expenditure of $25,000.

The Alberta Government has inaugurated its long distance system of telephones. It will start a line from Calgary to Banff. The construction of the work will be under the direction of Mr. James Grierson, of Calgary, who has been appointed superintendent of construction for the Alberta Government. The next work that will be done will be the building of a line from Edmonton to the east, probably as far as Lloydminster.

The annual meeting of the shareholders of the Great Northwestern Telegraph Company was held in Toronto last month, when the following directors and officials were re-elected: H. P. Dwight, Toronto, president; Adam Brown, Hamilton, vice-president; I. McMichael, Toronto, vice-president and general manager; James Hedley, W. C. Matthews, H. N. Baird, Hon. J. K. Kerr, Toronto; Col. R. C. Clowry, J. B. Van Every, New York; Secretary-Treasurer George D. Perry; Auditor, A. C. McConnell.

The improvements to the power house at Meaford, Ont., are now well under way. The new low pressure pump which is being installed was built by the Smart Turner Machine Company, of Hamilton. It has a capacity of 1,000 gallons a minute and rests on a soldid concrete foundation. The Jenckes Machine Company, of Sherbrooke, Que., supplied the boiler. A brick smoke-stack 50 feet high and 7½ feet square at the bottom has ben built and other improvements made.

HOW TO MAKE A SMALL ELECTRIC PLANT PAY.*

By D. F. McGee.

It has been proven that an entirely modern equipment is not essential for the financial success of an electric plant, and a wise manager of a small plant will hesitate before he consigns to the scrap heap equipment that he might, by overhauling and judicious arrangement, be able to operate at a net efficiency equal to the most modern equipment, besides saving for his company the amount required for new equipment and increased fixed charges that must necessarily follow such an expenditure. On the other hand, if he finds that his requirements and conditions call for an entirely new installation, he should not hesitate to make it, provided he can get the funds to do so—which is often difficult in a small plant.

The boiler room is usually the most neglected part of a small-plant equipment. Uncovered pipes, leaky valves and joints, improper boiler setting, careless firing and injudicious selection of fuel, are a few of the dividend-consuming devices common to small plants. It is well to have as few different sizes of valves, fittings, etc., as possible in the piping equipments. By making the nipples and short pieces of pipe of some uniform length, repairs will be simplified and many a shutdown be prevented, and a much smaller stock of fittings will provide for emergencies.

Boilers should be inspected at regular intervals and kept free from scale. Scale in boilers is often the cause of enormous waste of fuel. Every steam plant should have recording thermometers installed in the feed-water lines to boilers. The average engineer in the small plant does not realize the necessity of heating boiler feed water to, at least, 200 degrees.

Many central-station managers would have a rude awakening if they would take the trouble to install recording instruments. Recording voltmeters, as well as thermometers, will provide a healthy incentive for your men to attend to their duties, and will also provide a means by which that mystery of voltage variation, which has given us all so much trouble at various times, may be solved. It is well known that one of the chief difficulties in small plants is to have competent help available when accidents or other trouble occurs, which is generally during the time of the heaviest loads. We have provided for this by dividing the powerhouse force into three watches, with the understanding that they have to work 10 hours per day. This provides double force on duty two hours each day to make all repairs and tide over the peak-load period.

Engines should be indicated regularly, and valves adjusted for the most economical steam consumption. Tests of water and fuel consumption should be made at stated periods. A log book should be kept, showing records of the hourly readings of the various instruments. Daily readings should be made of the switchboard wattmeters. No plant is too small for those instruments. If a plant cannot afford load-curve drawing instruments, the engineer or switchboard attendant should plot the daily load from the ammeter readings. The curve thus drawn will bring before you plainly that hollow place in your load line that must be filled before you can corral that dividend-earning germ which we are all striving to cultivate with more or less success.

* Abstract of a paper read before the National Electric Light Association.

The distributing system of a small plant is very often the source of considerable waste. The annual losses from poor line construction, inefficient transformers and badly designed feeder systems would go a long way toward paying dividends. The line and transformer losses on above-mentioned plant at present are only 60 per cent. of what they were five years ago, when the income was only 25 per cent. of the present earnings. We scrapped 30 transformers and replaced the entire lot with four large ones, using three-wire secondary network with banked transformers to take care of this large increase of business.

The first duty of every manager is to provide for reliable and continuous service. He must furnish "the goods." Excuses won't go with the up-to-date American citizen.

His next duty is to his company. He must see that it receives an equitable return for money invested by it to provide the equipment to supply this service. Before he can do this, he must first know, beyond question, what constitutes the various costs that go to make up the entire operating expenses of the plant. He must be able to make a monthly comparison of his various costs, for it is only by this means that he will be able to keep a check on his operating expenses. By studying carefully all the facts and factors that constitute his costs, the manager will be able to steer clear of the folly of taking on unprofitable business.

In plants located in cities with populations of 10,000 and less, the manager must be familiar with every detail of his business. He must be his own solicitor. It has been said that an outside man can interest and get customers that the local manager cannot reach. If he can, it is because he is a man better fitted for the business. The manager of a small plant should know ways and means of approaching a prospective customer that a stranger cannot know. He should study the ambitions and weaknesses of every prospective customer. Often it is the wife and mother that should be approached, perhaps in an indirect manner. Very often it is the daughters of the house, who aspire to have as many conveniences as their neighbors. A hint from any source should not be neglected. There is always some way to land an interested party. A manager is not worthy of the name if he cannot find a way to do this.

Above all, a solicitor must be specific, and must be thoroughly posted regarding cost of installation and cost of operating the article sold; also regarding maintenance of same. He must be able to say, "Buy this; it will cost you so much to install and run, and will give you so much profit." He must be able to meet any argument that may be advanced by his competitors. Above all, he must be truthful. He must not make rash promises. It is well always to allow a factor of safety in this respect. How gratifying it is to hear from a customer that he is getting better results than you promised him. I can recall one incident that has afforded me considerable pleasure as well as profit. A German owned a blacksmith shop in our little city. After a lot of hard talking, I got him to install a small motor to operate his tools. Some time after, I called at his shop and inquired how he liked his power. He replied, "One boy put that thing in here, but it would take several good men to get it out again." As he is a very profane man, he used much more forcible language to express himself on

this subject. I have used this story many times since, and must say that it has helped to close up the sale of a good many motors.

It is not necessary to be a "hail fellow, well met." A man does not have to be a "mixer" in the accepted sense to get business. That fallacy has been exploded long ago. A pleasant, cheerful manner, and character to back up his arguments, is his best stock-in-trade.

The manager of a small plant must keep posted regarding the latest and most efficient types of different apparatus, lamps, reflectors, and so forth. He should read all the trade publications; not only the reading matter, but should study the advertisements as well. He will miss a great deal of valuable information if he does not. He will often find the solution in those pages of some difficult problem that has bothered him for months. Many manufacturing concerns gladly furnish binders for their literature. This matter, when properly assorted, represents a mass of valuable information that can be acquired in no other manner, so there is no excuse, save that "tired feeling," for a central-station manager not being up to date.

It is somewhat difficult to convince a customer that if his requirements call for a 25-horsepower motor, he would only have to pay for from 5 to 10 horsepower. A very large proportion of the load that can be secured by a small plant is intermittent. The customer averages a payment for only about 25 per cent. of his actual installation. By carefully studying the requirements of all prospective customers and familiarizing yourself with their actual costs, you are then in a position to go to anyone of those customers with a proposition that will save them money. If you can show the average man that you can cut down his expenses or decrease his manufacturing costs, you will have no difficulty in getting his business.

It pays to study every installation, giving your prospective customer your very best advice, for there is no advertisement so cheap and good as a satisfied customer. Above all, create confidence, for confidence is the foundation of new business. Pay every attention to the little things. The average user of power knows nothing at all about electricity or mechanics and cares less. What he wants is to see the wheels go round. Have your trouble man call at the various installations at stated intervals, making a report to you of any abuse or misuse of the equipments. The average patron will appreciate this. He can well afford to pay a small sum for this inspection to insure him against a shutdown.

Be prompt in looking after trouble. Let your customers know that their troubles are yours. Make yourself and your service indispensable to them; keep posted in regard to the troubles of users of other sources of power. We have often taken advantage of a breakdown in both steam and gasoline engines to install a motor to help them out of a difficulty, and we have never had occasion to take the motor out afterward, as the engine would invariably pass to the second-hand man.

With all due respect to advertising, it must not be thought, however, that the getting of new business, in a small city, is dependent on advertising alonn. There must be good and reliable service as a foundation for all this. The service must be continuous and free from interruption. Voltage must be steady. With such good voltage regulators on the market, there is no excuse for poor regulation. Customers' installations must be looked after by the central-station manager to insure their being maintained in good condition. He must watch the little things, keep dim or other inefficient lamps weeded out. At an early date we adopted a liberal policy regarding free lamp renewals.

It is also essential to have a schedule of rates that will attract the long-hour or all-day customers for both light and power.

You must educate the people away from the idea that electric light is for the well-to-do only, for the difference in the yearly cost for redecorating houses where electricity, gas or kerosene is used will often more than pay the entire electric-light bill for the year. Where electric light alone is used, the redecorating cost is about one-half as much as where it is where the other illuminants are used.

Regarding advertising in local papers, it is very necessary to retain their good-will, and some money can be spent in this manner to advantage.

A short time ago there was an epidemic of burglaries in our city. To one paper we furnished a news item, supposed to be an interview with a reformed burglar, stating that he always gave an electrically lighted house a wide berth while he was in the business, because he never could tell when a light would be snapped on him from an upper story.

To another paper we furnished a news item, to appear as a statement by a noted detective, advising people to have their houses wired, so that the lights in the lower rooms could be switched on from an upper story. We were inbebted to an electrical trade paper for this hint. We believe that we received more benefit from this one item in one issue of two newspapers than we should have received from a bona-fide advertisement running a year in the same papers. The idea is to take advantage of the psychological moment to instill your proposition into the minds of your prospective customers.

Advertising novelties are of questionable value to small plants. Every manager finds upon his desk every morning a mass of advertising matter, which he immediately consigns to the waste basket. There may be valuable matter hidden somewhere in this mass. The average manager has too many duties that demand his attention to waste it in wading through so much trash to discover them. Every business man has similar experience. We have found that the better way is to install a number of the articles, the sale of which we desire to push, in a number of carefully selected places, where they will be seen and talked about; and this, after all, is the only result to be gained by advertising. It is then up to the manager or his solicitor to strike while the iron is hot.

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WINNIPEG, MANITOBA, 60,000-VOLT HYDRO-ELECTRIC PLANT

BY V. D. MOODY.

Winnipeg, the metropolis of Northwestern Canada, the capital of the Province of Manitoba, in the richest wheat belt on the Canadian soil, with a population of 100,000, has recently completed one of the most modern water power constructions on the continent.

The City of Winnipeg is the distribution center of the Canadian Northwest, which is demonstrated by the great extensions and shipping facilities offered by the Canadian Pacific and the Canadian Northern Railway Companies, and the projections of the Grand Trunk Pacific Railways.

The possibilities of a manufacturing center were quickly grasped, and the project was taken in hand in 1901 by the Winnipeg General Power Company to harness the waters of the Winnipeg River for general power purposes, at a point distant a few miles from Lac du Bonnet, which is on a branch line of the Canadian Pacific Railroad, distant 65 miles from the City of Winnipeg.

In 1905 the Winnipeg Electric Street Railway Company, operating a steam station and controlling the street railway system, the general house lighting and power distribution, amalgamated with the General Power Company and became incorporated as the Winnipeg Electric Railway Company.

The advantages to be derived from such a hydraulic development were readily appreciated, due to the high cost of fuel for the operating expenses of a steam plant and the necessarily enormous cost of energy to the consumer; the cost of energy for operating the steam plant to the consumer being 12½ cents per kw-hour for general motor work and 20 cents per kw-hour for lighting, with the usual discounts for prompt payments of bills, which price with the new development will be reduced approximately 50 per cent., with discounts for prompt payments.

The power house is located on the opposite side of the Winnipeg River from Lac du Bonnet station. Difficulties experienced in conveying material to the site selected were overcome by building an eight-mile corduroy road from the river to the power house, and a similar eight-mile road from the power house to the headworks. The heavier electrical and mechanical machinery had to be conveyed in the winter when the ground and river were hard frozen, as the means of conveyance across the river at other times consisted of a small tug and barges.

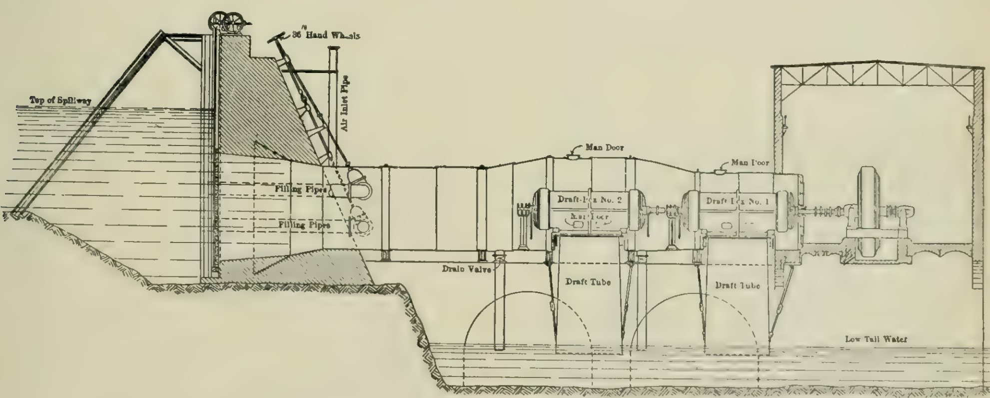


FIG. 1.—ARRANGEMENT OF MACHINERY IN POWER HOUSE AT LAC DU BONNET.

To obtain the necessary water, a channel had to be cut to the upper river near Otter Falls, 120 ft. wide, with a clear depth of 8 ft. at normal low water, the channel being 8 miles long with a drop of 5 ft. to the mile, equalling a total head of 40 ft. In cutting this channel it was essential to blast with dynamite about 447,000 cubic yards of granite, which was lifted out of the passageway by means of derricks. With the rate of flow of water through this channel and the avail-

able head there can be developed about 30,000 electrical h.p.

The greater part of the winter of 1902 was devoted to transporting the necessary material to begin operations in the spring. The development began with the excavations for the dam and tail race. At the point where the dam is located there is a natural fall, and the dam crosses almost at the crest.

Before starting these works it was essential to back up the water, which maintained from levels the year around at the point where the channel opened into the

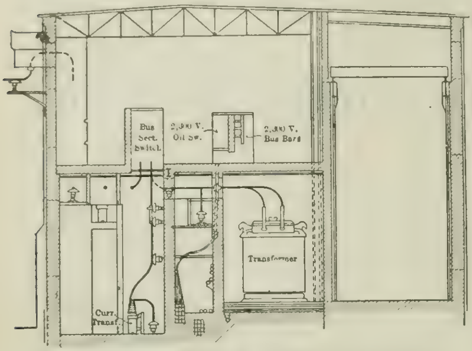


FIG 2.—CROSS-SECTION OF TRANSFORMER HOUSE.

river, eight miles from the power house, an average elevation of between 8 and 9 ft. This was done by means of a cofferdam.

The actual amount of granite excavations made and concrete constructions for foundations in cubic yards is given in the following tabulations:

Granite excavations.	Cubic yards.
Tail race	26,442
Power house	78,000
Head race	67,608
Intake	274,508
Grand total	446,553

Concrete construction in cubic yards: mixture, one part cement, three parts sand, five parts broken stone.

Forebay wall	6,621
South wing wall	2,416
North wing wall	2,369
Transformer house foundation	1,915
Power house foundation	4,503
Overfall dam (spillway)	4,600
Boom piers to catch debris, consisting of concrete piers spanned by floating logs	277
Controlling works	1,200
Ice rack foundation	110
Grand total	24,011

As soon as excavations had been made, the foundations were laid for the power house requiring 4,503 cubic yards of concrete, and for the transformer house and extension to the power house requiring 1,915 cubic yards of concrete. The dimensions of the power house between inside walls are: Length, 330 ft.; width, 31 ft. 9 in.; height from foundation, 39 ft. 7 in. Transformer house: Length, inside walls, 176 ft.; width, 53 ft. 1 in.; height, 36 ft. 9 in.

The buildings are absolutely fire-proof, being built of structural steel and brick throughout.

The main units in the power house consist of four 1,000-k.w. and five 2,000-k.w. revolving-field, 60-cycle, 2,300-volt, three-phase C.G.E. generators, coupled to McCormick tubines with Lombard governors; two 100-k.w. 125-volt, direct-current exciters, coupled to the same type turbines; and two 175-k.w. 125-volt exciters, coupled to three-phase, 2,300-volts induction motor.

The following tabulations give the generating station capacity:

No.	Water wheels hp.	Generators kw.	Speed r.p.m.	Voltage
4	1800	1000	200	2300
5	3000	2000	180	2300
2	200	100	600	125
2	Motor driven.	175	514	125

The generators have a manufacturer's guarantee of efficiency at full load of 95.5 per cent; regulation in percentage of full load volts, 4 per cent.

It is well to mention here that the turbine gates are protected by ice racks to keep out ice, logs, etc.

The switchboard is of black enameled slate and instruments of dull black finish. It is of the well-known benchboard type, and is located on a gallery about in the middle of the main generator room, where the operator can readily observe everything happening on the generator floor. The board sets on wooden beams. The controlling wires to the motor-operated oil switches, which switches are located in a gallery comprising the second floor of the transformer house, are run in 1¼-in. enameled iron conduit, as are also the generator and exciter field circuit leads. The exciter armature leads are run from the machines to the switchboard in 2½-in. pipes. The generator armature leads, consisting of cambric insulated cables, are run in 3½-in. tile duct to their respective oil switches—all of the conduit and duct being run in the concrete floors.

A general cross-section of the transformer house is shown in Fig. 2. The low and high-tension oil switch cells are on the second floor of the switch gallery. The switches are all three-phase, motor-operated, and each phase is separated by a 2-in. soapstone slab, the cells of the switches being separated from each other by 8-in. pressed brick walls. The low-tension bus compart-

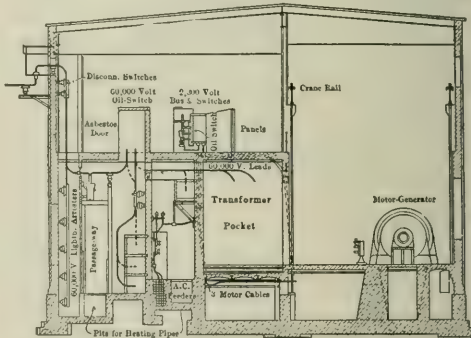


FIG. 3.—CROSS-SECTION OF SUB-STATION.

ments are directly behind the low-tension oil switches, each bus being separated by a concrete slab and each connector from switch to bus being separated by an 4-in. pressed brick partition. The low-tension buses are sectionalized by a motor-operated oil switch. The high-tension switch cells are placed 6 ft. 9 in. in front of the low-tension switches and consist of five transformer, one bus sectionalizing and two outgoing line motor-operated, 60,000-volt oil switches, their respective compartments and phases being separated by an 8-in. pressed brick wall. Each of the low and high-tension oil switches, low-tension bus compartments, lightning arresters and high-tension bus compartments is provided with an asbestos door.

From the low-tension buses, connectors run to the five low-tension transformer oil switches, two of which are on one side of the bus sectionalizing switch and three on the other side, the former and one of the latter controlling three banks of 1,800-k.w. transformers, and the other two switches controlling two banks of 830-k. w. transformers. From these switches cambric insulated cables are run through 3½-in. tile duct embedded

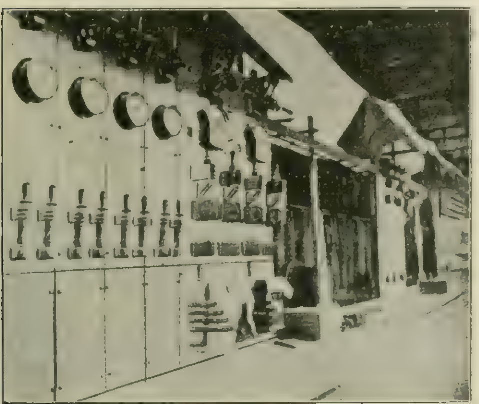


FIG. 4.—SWITCHBOARD IN SUB-STATION AT WINNIPEG.

in the concrete floor, to the low-tension side of the transformers themselves, which are located in brick compartments or pockets directly under the switch gallery, each transformer being in a separate pocket with a 12-in. brick wall on each side. The front of each pocket is provided with Kinnear steel doors.

There are fifteen transformers comprising five banks, consisting of two banks of 830 k.w. and three banks of 1,800 k.w. The secondary and primary coils are provided with taps for the following voltages: 2,200, 2,300, 2,400 volts secondary; 40,000, 50,000, 60,000 volts primary. The transformers are arranged for delta connections on both the high and the low-tension side; the voltage in operation is stepped up from 2,300 volts to 60,000 volts for transmitting to the sub-station at Winnipeg over a distance of 65 miles.

The 1,800-k.w. transformers bear a manufacturer's guarantee of efficiency at full load of 98.2 per cent; regulation non-inductive, 1 per cent; regulation, 90 per cent power factor, 2.5 per cent. The 830-k.w. transformers have a guarantee of full load efficiency of 97.7 per cent, the regulation to be the same as that of the 1,800-k.w. transformers.

For connecting up a bank of transformers, porcelain wall tubes 2½ in. inside diameter, 12 in. long, are placed between pockets, union couplings being provided on each transformer so that any one of a bank may be readily disconnected and two transformers run on an open "delta." The high-tension leads from the transformers out of the pockets to the high-tension delta consist of special copper tubes insulated in the same manner as the high-tension leads of the transformers. They are run on 60,000-volt porcelain insulators (tested for 120,000 volts) supported in the pocket by brackets and suspensions from the I-beams, and pass through the 16-in. brick back wall of the pocket through high-tension bushings, similar to those supporting the high-tension leads of the transformers.

Between the transformer pockets and the high-tension room, all of which are on the first floor of the transformer house, there is a passageway separated from the above-mentioned compartments by 16-in. brick walls, in which the high-tension delta compartments are located 12 ft. from the floor level. The insulators for carrying the wires, consisting of No. 2-0 hard-drawn copper, are supported by galvanized-steel pins in a three-inch concrete slab, each outgoing phase to the high-tension transformer motor-operated oil switch being separated in the delta compartment by a 4-in. pressed brick partition, all delta connections being made by copper connectors which may be readily disconnected. From the delta compartments the high-tension leads run on 60,000-volt insulators to the transformer oil switches and from the switches to the high-tension buses. The high-tension buses are separated by 3-in concrete slabs, carrying 60,000-volt insulators, faced by a 4-in. pressed brick wall. Where the high-tension wires run to the oil switches located on the second floor, each phase is separated by a 2-in. pressed brick wall faced with a brick buttress from the first floor to the switch gallery.

The lightning arresters are located in compartments of pressed brick in the high-tension room directly opposite the high-tension buses, and as in the case of the high-tension cells they are provided with asbestos doors about 7 ft. high. The lightning arresters are well grounded by a copper plate embedded in the mud in the tail race.

Disconnecting switches are provided between all oil switches and buses, both high and low-tension. The high-tension disconnecting switches are mounted on caps cemented to the heads of 60,000-volt insulators grouted by cement in the brick walls.

The transformers being of the oil and water-cooled

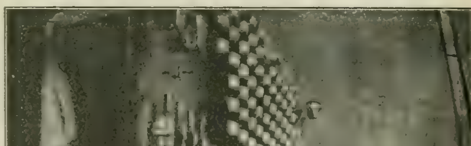


FIG. 5. VIEW OF SWITCHBOARD AT POWER HOUSE, SHOWING CONDUITS.

type, there is provided a duplicate system of piping for both water and oil valves, so that any one transformer or any bank can be cut off. The water piping is tapped from the tube of the exciter water wheel. The oil system is operated from oil tanks in the basement of the generator room by means of an air compressor driven by a three-phase, 220-volts induction motor, and which was furnished by the Canada Foundry Company.

There are provided three oil tanks, a receiving, a supply and an emergency.

The station lamps and auxiliary motors are operated from three-phase, oil-cooled transformers with secondary at 115 and 230 volts, controlled by an oil switch. Incandescent lamps are used throughout.

There is also located in the station a permanent water rheostat made of concrete with iron plates forming the three phases, which rheostat is connected to the buses by an oil switch.

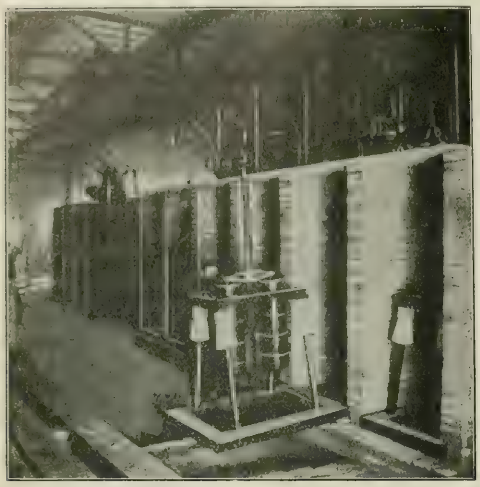


Fig. 6.—Installing 60,000 Volt Motor-Operated Oil Switches.

From the power house there are run duplicate transmission lines of No. 2-0 cable, with a hemp center, on steel towers to the sub-station at Winnipeg. The steel towers are similar to those used by the Toronto & Niagara Power Company, recently described in this paper. In erecting these towers many difficulties were experienced, due to the nature of the country to be traversed, which necessitated the lines being paralleled by a corduroy road for several miles. Twenty-one standard towers 40 ft. high had to be placed on piles near the Lac du Bonnet end between the Winnipeg River and the power house. The line crosses the Winnipeg river with a span of about 760 ft., on 72-ft. towers each weighing about 6 tons, with a sag in the line of about 23 ft. at 50° F. The standard towers are spaced 500 ft. apart, are 40 ft. high, and the line sags about 14 ft. at 50° F. Each tower weighs about 2,400 lbs.

There are four railroad crossings. The Red River crossing at Winnipeg near the sub-station has a span of about 1,100 ft., the towers being 105 ft. high, the sag in the line about 45 ft. at 30° F. Each 105-ft. tower weighs about 15 tons. The railway and the river crossing towers are built up on concrete footings. All of the towers are well grounded and are provided with lightning arresters, consisting of steel rods with ends pointed, bolted to the verticals and projecting mid-air above the highest point of the line. The transmission line, which has 10 complete transposition spirals, is paralleled by a telephone line of No. 8 hard-drawn copper wire, on the towers, which is transposed at each tower. The telephones are of the iron box type, purchased from the Mayer & Englund Company, Philadelphia, with 2,500-ohm ringers, so arranged that when the door of the telephone is closed the ringer is cut out of the circuit. These instruments are located every five miles along the line. There will be six patrolmen who will also be provided with a watch-case transmitters for testing purposes.

Where the line leaves the power house and where it enters the sub-station, there are left in the wall of the building openings in which are mounted 60,000-volt insulators, and on the outside of the buildings there are provided hoods of expanded metal with cement coating, the bottom of which carries a high-tension Locke bushing, using 24-in. tube, which has withstood test voltage of 130,000. The lines pass through these bushings over insulators supported on brackets to the towers. The line was designed for a drop not to exceed 10 per cent.

The general arrangement of the sub-station at Winnipeg is similar to that of the transformer house at Lac du Bonnet, the building being a brick and steel structure, having a length of 176 ft. and a width of 70 ft. 6 in., the height being 49 ft. 10 in.

The high-tension switches, the low-tension transformer and bus sectionalizing switches are of the motor-operated, oil type. The feeder and motor-generator oil switches are of the solenoid-operated type. Disconnecting switches are placed between the high-tension and low-tension buses and oil switches.

The switchboard is of blue Vermont marble and is provided with dummy buses. It consists of the following panels arranged in the order designated: Two two-circuit, direct-current power feeder panels, each circuit having 200-amp. ammeters, seven railway single circuit, direct-current panels, three of which have 1,200-amp. ammeters; four having 500-amp. ammeters; two two-circuit railway feeder panels, one of which has two 500-amp. ammeters, the other one 500-amp. and one 750-amp. ammeters; five two-circuit, 600-amp. railway feeder panels; seven 800-k.w. 600-volt, direct-current railway generator panels; seven 800-k.w. 2,300-volt, three-phase synchronous motor panels; five two-circuit, three-phase power feeder panels, capacity each two 550-k.w. 2,300-volt circuits; two three-phase, 5,400-k.w. step-down transformer panels, 55,000 to

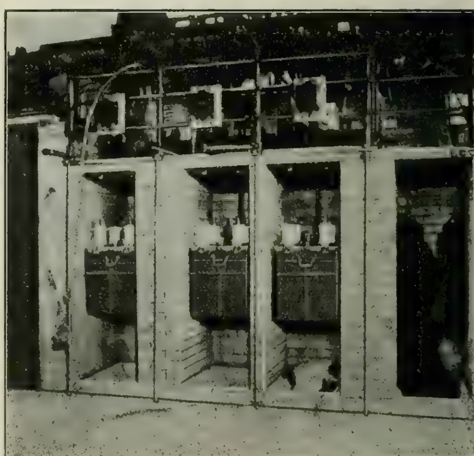


Fig. 7.—Low-Tension Solenoid-Operated Oil Switches at Winnipeg.

2,300 volts; one 2,400 k.w. 5,500 to 2,300-volt step-down, three-phase transformer panel; one three-phase, 15,000-k.w. 55,00-volt incoming line; one three-phase, 6,500-k.w. 55,000 to 2,300-volt bus sectionalizing panel; one three-phase, 15,000-k.w. 55,000-volt incoming line panel; three three-phase 2,400 k.w. 55,000 to 2,300 volt step-down transformer panels; ten two-circuit, 75-amp. single-phase feeder panels; three two-circuit, 550-k.w. 2,300-volt, single-phase feeder panels; with future extensions for 12 additional feeders.

All of the oil switches are arranged in hard pressed brick cells and all operating leads from the switches to the switchboard are run in 1¼-in. enameled iron conduit.

The source of supply for operating the motor-operated and solenoid-operated oil switches consists of 55 cells of chloride accumulators located in the basement of the building. The storage battery panel containing the 500-volt charging rheostat is located on the switchboard gallery about in the center of the main switchboard, where it is convenient for the operator. The low-tension buses are located in pressed brick compartments back of the low-tension switches, each phase being separated by a concrete slab.

The lighting feeders will consist of two-conductor cables, and the three-phase feeders of three-conductor cables run in 3½-in. tile duct from the top of the switch cells through the cableway, which consists of a passageway between the high-tension rooms and the transformer pockets, to cable bells, then through 3½-in. tile duct to manholes in front of the station to points of distribution. An interesting device used with the lighting feeders is an auxiliary lighting bus, so arranged with disconnecting switches on a marble base located in the cableway that the lighting feeders from each of the oil switches tie on to the disconnecting switches, which are also connected to the auxiliary bus, and in case any lighting feeder oil switch goes out of commission the load on the particular switch, by means of the disconnecting switches, may be transferred to any other oil switch by means of the bus, making the lighting system entirely flexible. The lighting feeders are also provided with single-phase, motor-operated feeder regulators, each having a secondary wound for 150-amp. 115-volt 10 per cent. boost or lower, the regulators being oil-immersed and self-cooled.

The arrangment of the high-tension compartments, transformer pockets and delta connections are similar to those at the transformer house at Lac du Bonnet. All of the cells for oil switches, lightning arresters and high-tension compartments are provided with asbestos lumber doors.

In the sub-station there are provided six 1,800-k.w. and nine 800-kw step-down transformers. The transformers are oil and water-cooled, with the same guarantees as to efficiency and regulation as those at the power house.

For direct-current railway and stationary motor work the ultimate capacity of the station will be seven 800-k.w. synchronous motor-generator sets operating at a speed of 400 r. p. m., with 2,300 volts on the alternating side, 550 to 600 volts on the direct side. The generators may aloo be operated as shunt-wound generators at 600 volts. With a proper shift of the brushes the direct-current machine may operate as a direct-current motor, giving 630 to 700 k.w. from the synchronous motor operating as a generator. These machines are provided with 17-k.w. 125-volt exciters mounted on brackets on the extension of the synchronous motor shafts, and are provided with speed-limiting switches and end play devices.

The manufacturer's guarantees on the motor-generators are: Temperature rise at normal load is not to exceed 35° C., and at 50 per cent. overload for two hours not to exceed 55° C. The efficiency of the synchronous motor when used as a motor is 93 per cent. at full load, 92 per cent. at three-fourths load, and 90 per cent. at half load. When the synchronous motor is used as a generator at 100 per cent. power factor the full load efficiency is 95 per cent., the three-quarter load efficiency is 94 per cent., and the half load efficiency is 92 per cent. The above efficiencies are ascertained by including the exciter losses. The machines are also guaranteed to carry a 100 per cent. overload momentarily without undue sparking. The direct-current generator has an efficiency of 93 per cent. at full load and at one and one-half full load. At three-quarter load the efficiency is 91 per cent., while at one-half load it is 88 per cent. The temperature rise of the machine after a 24-hour run at normal load and 575 volts does not exceed 35° C.

The synchronous motor armature leads run from the top of the oil switch cells through 3½-in. tile duct on insulator racks in the basement to the respective machines, the cables being insulated with cambric. The field circuit leads of the motor and the armature and field circuit leads of the exciter are laid in concealed pipes back of the respective motor panels to insulator racks in basement. The generator leads run from the machines on insulator racks in the basement through concealed 2½-in. pipes to the back of their respective panels. The motor-generators are located on the main floor of the building.

The railway feeders run from the back of the panels in concealed 2½-in. pipes to the basement under the main floor through tile duct to manholes in front of the station to the points of distribution. All of the conduit work in the station runs in the concrete floors and brick walls, excepting the lighting circuits of the station, which are not concealed. The lamps and auxiliary station motors are fed from three-phase transformers, 2,300 volts primary, 115-230 volts secondary. There are duplicate oil and water piping systems for the transformers, the former being operated by an induction motor-driven air compressor, the latter by an induction motor-driven centrifugal pump.

Tne most essential feature in the station construction is the absolute protection to life and apparatus afforded throughout. The cost of the complete plant will amount to approximately $4,000,000.

The officers of the Winnipeg Electric Railway Company are as follows: William Mackenzie, president; William Whyte, vice-president; F. Morton Morse, secretary and treasurer; W. Phillips, manager. Dr. F. S. Pearson, of New York City, is the consulting engineer of the whole work, the details of which were carried out by Mr. L. J. Hirt, as mechanical and hydraulic engineer for Dr. Pearson.

The electrical apparatus was furnished by the Canadian General Electric Company, Limited; the turbines by the S. Morgan-Smith Company; the towers, air compressors and centrifugal pumps by the Canada Foundry Company, Limited; transmission line copper by the Ansonia Brass & Copper Company, and the insulators by the R. Thomas & Sons Company. Electrical World.

Testing Alternating Current Apparatus by the Behrend Method

In connection with the remarkable performance of the 8000 h. p. frequency changer installed at Shawinigan Falls, Quebec, which it is claimed has resulted in the highest efficiency of transformation from 30 to 60 cycles ever attained, it is of interest to note the method devised by B. A. Behrend, chief electrical engineer of the builders, Allis-Chalmers Company, for testing alternating-current generators and synchronous motors, under full load conditions, while they are still in the shop. It is not always possible, with the large sizes of units of the present day, to supply the driving

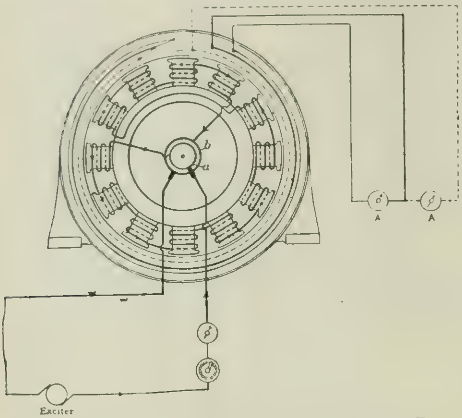


Fig. 1.—Diagram for Mordey's Combination of Field Coils for Circulating Power Test.

power for test required at full load and at over load, and, therefore, methods of test have been devised in which the driving power is limited to that available in shops of the manufacturer. The machines must be put under conditions such as load to full losses in the core and the coil of the machines.

The alternating current, by means of its property of being able to store energy during one-quarter of a period, and return it during the next quarter, allows the flow of large amounts of apparent energy in the form of so-called wattless currents. It is possible, by properly exciting two alternating-current machines operating in parallel, to circulate a large quantity of apparent energy without having to supply more true energy than corresponds to the losses which take place in the machines. Such motor-generator tests, consisting in operating an alternating-current machine as a motor, running idle, have been made by Mr. Behrend for many years, and have been used for the determination of the regulation of alternators on low power-factors, as well as of the heating under the same conditions.

But this method of testing requires two machines of the same capacity and involves the expenditure of power corresponding to the losses of two machine. The first to suggest the circulation of power within a single machine was Mr. William M. Mordey in a paper, Volume II., 1893, of the Journal of the British Institution of Electrical Engineers. Mr. Mordey's method applied, for instance, to a single-phase genorator, having twenty poles on each side of a single exciting coil, would be carried out by splitting the armature into two sections of eight and twelve coils respectively, and by connecting these sections in opposition so that only four coils would be effective in regard to the circulation of current through the armature. The section of the armature which contains eight coils acts as motor, while the section containing twelve coils acts as generator. The current which circulates through the armature coils is almost in quadrature with the resultant e.m.f., and is, therefore, a wattless current. Hence, the eight poles of the motor section of the machine will be strengthened by the armature current, whereas the twelve poles of the generator section of the machine will be weakened by the same current. This leads to a magnetic unbalancing of the machine, as the motor fields carry more resultant flux than the generator fields. In Mordey's machine, this condition may not have caused trouble, as his machine does not contain iron in the armature ; but in modern generators his method cannot be used on account of the magnetic unbalancing of the machine. Instead of dividing the armature into two sections and connecting these sections in opposition, it naturally suggests itself, especially on polyphase machines of the revolving-field type, to split the field into two sections and to connect these sections in such a manner that the e.m.fs. induced in the armature are in opposition. This method cannot be carried out in practice, as the machine vibrates and jars in a manner which makes its operation under such conditions impossible.

Referring to Fig 1, which represents Mordey's combination of field coils, we see that the current in the armature strengthens the field of the poles which act as motor and weakens the field of the poles which act as generator, as represented Fig. 2. The magnetic attraction between the revolving and stationary parts being proportional to the square of the induction in the

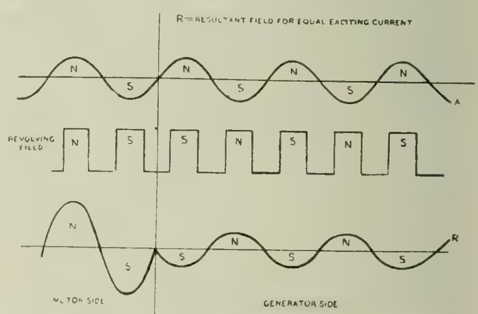
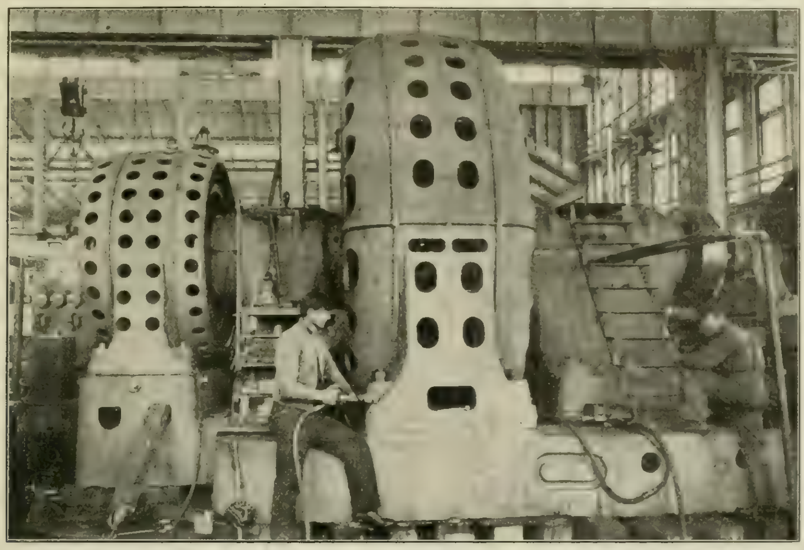


Fig. 2.—Diagram Showing Effects of Armature Currents in Mordey's Test.

air-gap, we see at a glance from Fig. 2 that the conditions of operation are impossible, on account of the unbalanced magnectic forces. In order to circulate power succcssfully within a single machine, it is thus essential to obtain uniform induction in the air-gap of both the motor and the generator poles. As the armature reaction strengthens the motor poles and weakens the generator poles, the impressed excitation of the motor poles must be smaller than the impressed excitation ot the generator poles, and this can be effected as shown in Fig. 3 by splitting the field coils into two sets of an equal number, excited with different field currents. Fig. 4 shows the effect of the armature



An 800-H. P. Allis-Chalmers-Bullock Motor Under Full-Load Test by the Behrend Method. This Motor is Claimed to be the Largest Ever Built, and Forms Part of a Frequency Changer Installed at Shawinigan Falls, Quebec.

reaction on the poles. Both in Fig. 2 and 4 the wavy line "A" represents the field produced by the armature current alone, and wavy line "R" represents the resultant magnetic field.

Fig. 5 represents the regulation curves on low power-factor obtained by first running a synchronous motor from the generator and secondly by circulating power within the machine itself. The agreement between the two methods is very satisfactory. Numerous experiments have been made on machines designed by the author to check the new method against the synchronous motor-generator tests, and the results have shown a very close agreement.

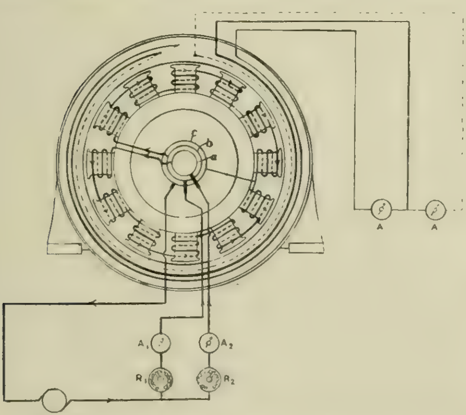


Fig. 3.—Behrend's Combination of Field Coils for Circulating Power.

Fig. 6 shows the regulation curves of a 3000 k.w., 26-pole, 50-cycle generator, obtained in this manner. Fig. 8 shows the regulation curves of a 3200-k.w. fly-wheel type, 96-pole, 60-cycle generator. Fig. 9 shows the regulation curves of a 3500-k.w. 40-pole, 25-cycle generator, forming a part of the unit known as the "Big Reliable", which supplied power and lighting current to the World's Fair at St. Louis.

The terminal voltage corresponding to the conditions under which the machine is operating in the test can be determined by measuring the volts on a set of coils per pole multiplied by the total number of

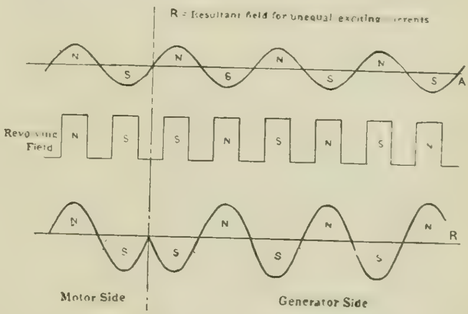


Fig. 4.—Diagram Showing Effects of Armature Currents in Behrend's Split-Field Test.

coils, or by adding to the excitation on the motor fields the excitation required to drive the armature current through the armature winding. Both methods have invariably given the same results.

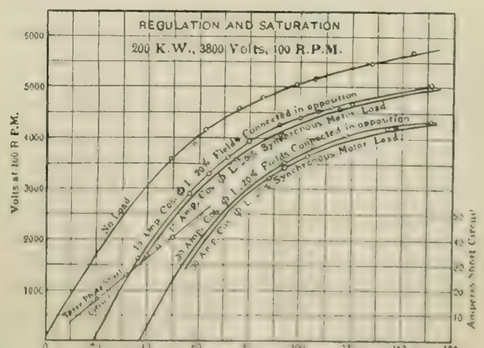


Fig. 5. Comparison Between Regulation Curves Obtained by the Synchronous Motor-Generator Test and by the Behrend Method.

Numerous tests have been made to ascertain the actual losses in operating the machine in the manner decribed by splitting the field. Fig. 7 shows the comparison between the core loss of the machine, as determined in open circuit run, with losses as obtained in

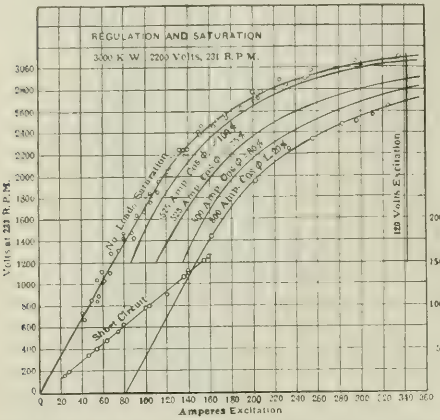


FIG. 6.—REGULATION CURVES FROM A 3000 K.W. ALTERNATOR.

the split-field test; one set of readings is shown by the open dots, the other by the dark ones. These tests were carried out on a 1000-k.w. 25-cycle, 32-pole generator.

The heat runs obtained by this method on the machine and on a 3200-k.w. machine, at full normal load

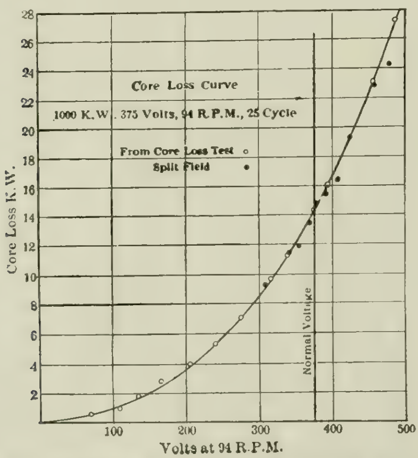


FIG. 7.—COMPARISON OF CORE LOSSES OBTAINED ON OPEN CIRCUIT AND IN THE BEHREND SPLIT-FIELD TEST.

in kilo-volt-amperes and power-factor zero, yielded the following results:

HEATING TESTS.

	3500 K.W.	3200 K.W.
Volts	6600	4500
R. P. M.	75	75
Frequency	25	60
Hours	18	23
Loads K.V.A.	3500	3870
Temperature Rise, Degrees Centigrade :		
Armature Surface	30	27.5
Armature Coils	34	31.5
Field Coils	34	31.5

It is hard to imagine a simpler method of testing than the new method described. The course of evolution in engineering has always been from the complex towards the simple. It has taken many years to evolve this method of testing which enables us to obtain with comparative ease the most important data of the performance of alternating-current generators. The only drawback of the method consists in the fact that it is applicable only to machines having a comparatively large number of poles. It has not been successfully applied to machines having fewer than eight poles. The application of this method is confined to machines of the slow speed type; and with the advent of the steam turbine generator, new methods will have to be devised to produce artificially full-load losses without the expenditure of full-load power.

INTERESTING PATENT DECISION.

In the Hull Superior Court last week a consent judgment was entered for Mr. John Murphy, electrical engineer, in his suit against the Ottawa and Hull

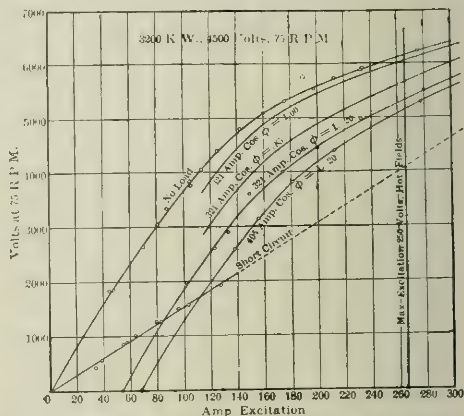


FIG. 8. REGULATION CURVES OBTAINED FROM A 3200-W.K. ALTERNATOR BY THE BEHREND METHOD.

Power and Manufacturing Company for infringing his patents for combatting anchor ice and frazil. By the terms of the judgment rendered the validity of the patents is admitted, and it is understood that a substantial sum has been paid by the Power Company for the use of the patents in question.

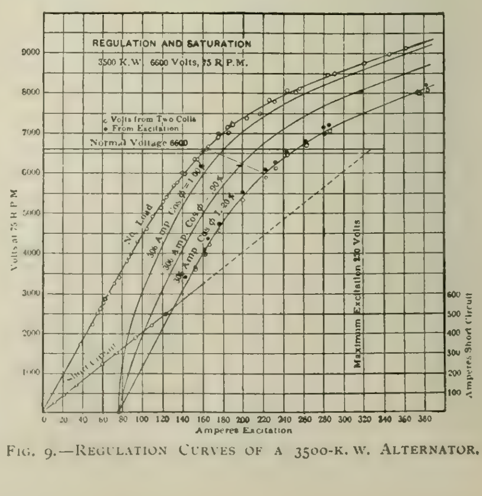


FIG. 9.—REGULATION CURVES OF A 3500-K.W. ALTERNATOR.

EXPERIENCE ON THE ROAD

By K. E. Sommer.

A POLARITY INDICATOR.

A short time ago a report was received stating that two 75 k.w., 125 volt generators would not operate in parallel. On arriving at the plant and making an examination, the connections from the generators to the switchboard were found to be correct. The generators were then tested separately with the available loads, and their behavior as to commutation, compounding, etc., was all right. When thrown in parallel the circuit breakers opened instantly. Opposite polarity alone could have caused such sudden results, inasmuch as both generators were of the same voltage when paralleled. Apparently the switchboard voltmeter, although marked "Direct Current," was not an indicator of polarity. The writer had no portable Weston instrument at hand. Recourse was therefore had to a tumbler of acidulated water in series with an incandescent lamp as a preventive resistance. This device was connected successively across the terminals of each generator. In one case bubbles appeared in the water at one terminal, in the other case at the other terminal, indicating that the generators had been paralleled when of opposite polarity. One machine was "re-flashed" from the other by passing an exciting current in the proper direction through its field winding, and no further trouble was experienced with parallel operation.

ROTARY CONVERTER TROUBLE.

A 200 k.w., 60 cycle, 600 volt rotary converter was reported operating unsatisfactorily. It was suggested that the lowering transformers might be connected improperly, or that the insulation of the converter was imperfect, in fact a number of causes for the unsatisfactory operation of the machine were advanced. Investigation showed the transformer connections were all right, and the insulation of the machine not defective. The substation operators reported that at times the rotary operated very satisfactorily, and at other times very unstisfactorily. The writer decided to observe operations closely for a few days. Readings of loads were taken for three or four days and the behavior of the machine and time of readings noted. The power for this converter came from a large lighting and power station. Through the kindness of the superintendent of the company, access was had to the switchboard record sheets. On comparing the writer's observations and the switchboard attendant's sheet, it was noted that the operation of the converter was always bad when two particular generators in the power house were supplying power to the bus-bars to which the converter was connected. When the other generators were supplying the power, the operation of the converter was good, and particularly with one 3000-kw. fly-wheel type generator supplying power, the behavior of the converter was very good indeed, loads up to 100 per cent. momentary overload being satisfactorily carried. It was found that the machines that supplied power during the periods of unsatisfactory operation of the converter did not have copper dampers. As the rotary itself was obviously not defective, an agreement was entered into between the railway company and the power company, by which the latter was to furnish power only from the generators which gave satisfactory service.

ALTERNATOR TROUBLE.

A telegram in this case read: "Go at once to——ville, lighting company cannot get voltage from generators." At the plant were two single-phase belted generators, a 90 k.w. machine of modern type, and a 150 k.w. of an obsolete type, purchased from a second-hand dealer. The 90 k.w. generator was found running at 2,100 volts as indicated by an instrument having a 2,500 volt scale. By adjusting the compensator brushes, a reading of 2,300 volts was obtained, or 200 volts higher than the desired operating voltage. The 150 k.w. generator could not be made to show more than 2,150 volts, although the speed was approximately correct and ample separate excitation was provided. A Weston portable voltmeter was attached to the secondary of the switchboard voltage transformer of the 150 k.w. generator. The Weston instrument indicated 2,350 volts simultaneously with the switchboard reading of 2,150 volts. The Weston voltmeter was then connected to the voltage transformer of the 90 k.w. generator, and this reading checked exactly with the simultaneous reading of the switchboard instrument. As the 90 k.w. generator had an armature with distributed winding and the 150 k.w. generator had a "toothed" armature, the voltmeter discrepancy was evidently due to the distorted wave form of the 150 k.w. machine. The Weston instruments indicate correctly the effective value of the e.m.f. irrespective of wave form; while the deflection of the switchboard instrument, which was of the type "K" style, is effected by the wave form, owing to the variation in permeability of its iron parts at different indications. As a matter of fact, the type "K" instruments should be especially calibrated for use with currents of distorted wave form. It was next decided to operate the machines in parallel, but owing to the distorted wave form of the 150 k.w. generator, parallel operation was unsuccessful, and another generator was purchased in place of the "toothed" armature generator.

BALANCE COIL TROUBLE.

In another case, undue heating of the balance coils, used in connection with a 20 k.w. 250 volt, three-wire generator, was reported. The voltage and frequency were found to be correct, as were also the connections between the generator and the balance coils. The loads were not above the rated capacity, nor was there excessive unbalance. A 25 ampere alternating-current ammeter was placed in the circuit of the phase "A" balance coil, while the brushes were raised from the collector rings connected to the phase "B" coil. The magnetizing current was inappreciable, being too small for accurate reading on the ammeter. The brushes were then placed in position on the phase "B" collector rings. With both balance coils connected and zero load on the generator, the alternatng-current ammeter read 12.8 amperes. The ammeter was then placed successively in each leg of the circuit to the balance coils, with approximately the same result in each case. With direct-current loads of 46 and 30 amperes per side, the alternating-current ammeter reading increased only to 14.9 amperes from the 12.8 ampere reading at zero load. Indications pointed to incorrect connections from the armature winding to the collector rings and an examination showed that the taps from the commutator to the collector rings were made from bars Nos. 1 and 13, 25 and 36, whereas the taps should have been made from bars 1, 13, 25, and 37. The error was at once remedied and the balance coils gave no further trouble.—The Electric Journal.

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Gas Engine Governing. Probably a greater advance has been made in the development of governors for internal combustion engines than in any other part of such machines, and this is doubtless due to the rigid demands of direct electrical drive. The first gas and gasoline engines put on the market many years ago were naturally of limited capacity, and the "hit-and-miss" method of governing answered the purpose very well. As is well known, this governor, which may be applied in many different ways, varied the number of explosions per minute while endeavoring to keep the number of revolutions constant. Thus, when the engine was running light, there would be but one explosion in twelve or sixteen revolutions of the fly wheel, whereas under full load conditions one explosion would take place for every two revolutions, or, as it is generally stated, every fourth stroke, the forward and the backward movement of the piston each counting as a single stroke. With the development of larger units, the hit and miss system was anything but satisfactory, and the regulation of the engines was such as as to preclude the possibility of driving electrical apparatus except where countershafts were used, upon which were mounted exceptionally heavy fly wheels. The principle of the steam engine governor, namely, the admission into the cylinder of a sufficient quantity of steam at each stroke to perform the work required, was then modified so as to be adaptable to gas engine practice, and the larger sizes of engines were forthwith equipped with an ordinary throttle governor. The mixture of gas and air was controlled by valves for the purpose, and which were capable of continual adjustment where such adjustment was required, and the function of the governor was to admit at each stroke a sufficient quantity of the mixture to enable the engine to deliver the power required of it. Practically all large engines to-day use this idea, modifying it in various ways so as to suit the peculiarities of the machine to be governed. Engines injecting crude oil or gasoline directly into the cylinder simply vary the quantity of each injection according to the load on the engine, the amount of air being constant at each stroke. Very recently a governor has been designed by an English manufacturer which is claimed to be superior to the standard throttling type. The engine is of the well know multi-cylinder design, and each cylinder is fitted with a single cam-operated exhaust valve. There are, however, two inlet valves in each cylinder, one of which admits the explosive mixture, and the other admits air. In the air passage to the air inlet valve, a butterfly throttle is placed, and when the speed of the engine tends to increase, this throttle opens and allows more air to pass into the cylinder during the suction stroke, the result being that less of the explosive mixture is drawn in. With a tendency to decrease in speed, the action is of course reversed, and a richer mixture is used. One of the great advantages of this system is that automatic ignition can be effected equally well on all loads, due to the fact that the compression on light loads is as great, if not greater than that obtainted at full load. The difficulty with the ordinary throttling system of governing is that on light load such a small quantity of the explosive mixture is admitted into the cylinder that the compression is poor, and this fact also has a material effect upon the mechanical operation of the engine. This new system of governing apparently supplies a

long felt want, and we anticipate that it will meet with a material success.

Testing. Elsewhere we print an exceedingly interesting and valuable article on the testing of large alternating current generators under conditions which approach very closely a full load temperature run, the idea having been developed by Mr. B. A. Behrend, of Cincinnati. In many cases, or in fact we might say the majority of cases, it is extremely difficult to obtain power at the point of manufacture for driving large generators at full load, and equal trouble is often experienced in obtaining some means of loading the machines. The simple process of reversing one half of the field and slightly raising or lowering the excitation of that half, will produce a very small difference of potential at the terminals of the armature circuits, across which a variable resistance may easily be connected. The heating in a generator, when operating at full load, is from two sources, namely, the iron and the copper, and it is quite safe to say that the principal portion of this heating comes from the former. Thus to approach a full load running test, two runs are often necessary, one being with the field of the machine very slightly excited, and a short circuit placed across the terminals of the armature. The machine is run at standard speed and the field adjusted until the ammeter in the short circuit connections shows full load current flowing through the armature. The other test is one in which no current flows through the armature, the leads being left entirely unconnected. The machine is run at proper speed, and the field current adjusted to give full voltage across the armature terminals. The field current is then increased to seven-sixths of this value, and the machine run for a proper number of hours.

It might be pointed out in connection with the former test, that the heating of the armature is very slight, and practically no heat is noticeable in the field coils, as the current circulating through this part of the system will be of very small value. On the second test, however, after a run of four to twelve hours, depending upon the size of the generator, a temperature will be reached in the armature practically equal to that obtained by running the machine at full load current and full voltage for an equal period. On either of the above tests very little power is required to drive the generator. On the Behrend system, however, as elsewhere described, full load field current is used, and full load armature current is obtained at the same time, thus almost duplicating a standard full load run condition. The fact that one half of the field is reversed makes the voltage in one half of the armature buck that of the other half, and if the two halves of the field are equally excited, the voltage at the armature terminals will be zero, and the voltage between each armature terminal and the middle point of the armature coils will be one half normal full load voltage. In order to obtain full load current through the armature, one-half the field must be excited slightly more than the other half, and thus a small difference of potential is obtained across the armature terminals, which, as previously stated, may be connected to a variable resistance so adjusted as to allow full load current to flow. This system of testing will be most useful in shop practice, particularly when applied to machines designed for direct connection to steam engines or water wheels.

It has been the practice of some manufacturers to run the two tests previously mentioned, but this, as will be appreciated, takes twice as much time as any method which will give a satisfactory test with a single run. When such machines are set up in service, there is probably capacity in the prime movers to supply the necessary power for a full load run, but considerable difficulty may be experienced in obtaining a steady and satisfactory load. Where direct current machines are run in the erecting shops, the problem is simplified, the standard loading-back idea being used to a very great extent, especially where two generators of the same voltage and design come through the shop on one order. These machines are belted together, and the entire output of the generator is delivered to the other machine, which acts as a motor, and delivers in the form of mechanical energy almost enough power to drive the generator. The slight loss, due to the fact that the efficiencies of the machines will be below one hundred per cent., and to the belt friction, is made up by a third machine of comparatively small size, which is belted in some manner to the shaft of either of the machines under test. Where there are two machines of the same size, as just mentioned, the one run is practically a temperature run for both machines, and where, in large sizes, this may require a matter of fourteen to twenty-four hours, a considerable saving of time is effected, and the test is conducted with the consumption of very little power. Alternating current generators, however, cannot be tested in this way, and hence some other method has necessarily to be used. When installed in their final locations, a full load temerature run by the engineer in charge is a very desirable thing, but the difficulty experienced in obtaining a load is often a hindrance to the carrying out of such test. On low voltage machines, a resistance can often be made up of iron wire placed across the armature terminals, and this resistance, when immersed in water, can be made to carry a current considerably greater than that required to fuse the wire in air. This method affords a very satisfactory way of providing a load. On high voltage machines, the great length of wire required for such resistance almost precludes its use, and recourse is then had to the water rheostat. Three phase generators of five hundred volts may be loaded upon barrels, each barrel being arranged as an independent three phase rheostat through use of three iron pipes. With the water being constantly replenished, a load of about one hundred kilowatts can be carried on each barrel. In twenty-three hundred volt work, however, a three phase barrel rheostat of this design cannot be used, as a considerably greater space is required between the pipes. Where the water in the barrels is not changed, the maximum continuous capacity per barrel does not exceed twenty-five kilowatts, from which it will be seen that to load a large size generator a great number of barrels will be required. Generators, when installed in hydro-electric plants, can often be loaded with a three-pipe rheostat placed in the tail-race or forebay, or in fact any place where there is a constant flow of water. The trouble from steam and the heating of electrodes can thus be avoided. This, of course, provides a satisfactory load, but we are inclined to think that the Behrend idea will find considerable application even where such conditions exist.

THE NERNST LAMP*

By A. E. Fleming.

In presenting a paper on the Nernst lamp it is hardly necessary to mention the characteristics or the essential parts at this late date, and as the development work was so thoroughly covered by Mr. A. J. Wurts in his paper presented to the American Institute of Electrical Engineers in 1901, practically nothing need be said regarding research and development work. However, as there may be some present who have not had the opportunity of reading Mr. Wurts' paper, a brief decription of the parts, as given by him, may not be out of place.

The nucleus, or light-emitting element of the lamp, is termed a "glower". It is made by pressing through a die a dough composed of the oxides of the rare earth mixed with a suitable binding material. The porcelain-like string thus formed is cut, after drying, into convenient lengths. It is then baked, and terminals are attached, by means of which a current of electricity may be passed through the glower.

The terminal connection between the glower and the lead wire, as first made, consisted of a few turns of platinum wire wound around each end of the glower, the convolutions being finally pasted with cement. Another successful terminal is one in which beads of platinum are embedded in the glower ends and to which lead wires are subsequently attached; with this, any shrinkage of the glower material results in a firmer contact with the platinum.

The glower of a standard 220-volt Nernst lamp is about 1″ long by 1/32″ in diameter. This glower possesses many interesting features and advantages. It is an oxide incapable of further oxidation, therefore operative in the open air, and being capable of constantly withstanding a much higher temperature than is the filament of the ordinary incandescent lamp, it admits of great economy of operation and provides a superior color and quality of light. Glowers are insulators when cold, but become conductors when hot, hence they must be heated before they will conduct electricity sufficiently well to maintain themselves at a light-emitting temperature.

The characteristics of the glower with reference to voltage and current is remarkable. As the current traversing the glower is increased, the voltage across its terminals rises, at first rapidly, and then more and more slowly to a maximum; it then drops off with increasing rapidity as the current through the glower and the resulting temperature continue to increase. Beyond the point of maximum voltage, the rapid decrease in the resistance of the glower makes the current difficult of control. Without a steadying resistance, such a conductor would rapidly develop a short circuit and "flash out". In the Nernst lamp this steadying or ballasting is accomplished by means of a fine iron wire mounted in a small glass tube, somewhat resembling a miniature incandescent lamp. The diameter of this wire in a .4 ampere ballast is less than .002″—smaller than a hair.

To prevent the rusting or oxidation of this fine iron wire, which at the operating temperature would occur immediately in the open air, the enclosing bulb is first exhausted of air and then provided with an inert atmosphere consisting of hydrogen gas. This gas has no injurious action upon the iron, while its great heat conducting capacity permits of the use of a smaller wire, and therefore of a much smaller ballast than would be possible with other gases.

The decided negative resistance temperature co-efficient of a glower may thus be more than counter-balanced by the more pronounced positive temperature co-efficient of the iron wire ballast placed in series with it. This exceptional charateristic of the ballast is demonstrated by the fact that for a 10% rise in current the resistance in the ballast increases 150 per cent., so that a glower thus protected at once becomes operative through a wide range of voltage.

It is important to have the corrective property of the ballast immediately available to check even a momentary rush of current through the glower at starting, or in fact at any time. This requires that the ballast shall possess small heat capacity. To attain this important feature, the iron wire is mounted freely in the gas contained in the glass envelope and is thereby capable of instantly assuming the new temperature imposed upon it by a change in line voltage.

The construction of a commercial and entirely automatic lamp requires, in addition to the glower and ballast, a device to provide for the initial heating of the glower. Though numerous methods of effecting this heating have been suggested and tried, it is natural that electrical means should prove to be the more practical.

The glower becomes a good conductor at about 600 or 700 degrees Centigrade. To acquire such a temperature quickly and without rapid destruction of the heater and adjacent parts, renders the selection of materials for the purpose a serious problem. Platinum for the heater may seem costly for the commercial lamp, but although many attempts have been made to devise a cheap mineral heater, platinum is still the least expensive, the most durable, and altogether the most desirable for the purpose.

The heaters consist of thin porcelain tubes overwound with fine platinum wire which in turn is held in placed and protected from the intense heat of the glowers by a refractory paste.

The lamp is constructed with an automatic cut-out to disconnect the heater from the circuit as soon as the glowers light. The cut-out comprises a coil, an armature and a contact.

The coil is heat proof, being embedded in cement. The contact is non-oxidizable, being of silver.

In the development of the lamp the fact that a superior distribution of light could be obtained from units placed well above the line of vision resulted in the glower being made in the horizontal, thus giving a downward distribution of light which was a radical departure from that previously used in both the arc and incandescent lamps. That this distribution is best suited for general interior lighting has recently been approved by all manufacturers now making the new forms of high efficiency incandescent lamps and also those manufacturing the flaming arc. It is not

*Paper read before the Toronto Branch A.I.E.E., November 9th, 1906.

the intention of this paper to go into the photometric values of the Nernst lamp or make comparisons with other forms of illumination. A few figures taken from a series of tests conducted by the Nernst Lamp Company may be of interest. These are based on readings taken at the 90° angle below the horizontal, lamps being equipped with light sand blasted globes, as this type of globe is mostly used in commercial work:

1 glower lamp	64.5 candles
3 glower lamp	200.6 candles
4 glower lamp	314.3 candles
6 glower lamp	472.7 candles

The mean hemispherical efficiency of the lamps was as follows:

1 glower lamp	2.43
3 glower lamp	2.11
4 glower lamp	1.84
6 glower lamp	1.76

From the above it is clearly shown that the efficiency of the lamp increases with the number of glowers contained in the lamp. This is due to the negative temperature co-efficient of the glower material and to the fact that the several glowers tend to heat each other in proportion to the number of glowers used.

To determine the illuminating power of the different units, a room was equipped in such a manner that comparisons could be made between different kinds of illuminants, and it was found that the one glower lamp consuming 88 watts was equivalent to 3-16 c.p. incandescent lamps or one gas mantle. A two glower lamp consuming 176 watts will replace 7-16 c.p. incandescent lamps; a three glower lamp consuming 264 watts would be equivalent to 10-16 c.p. incandescent lamps or one four burner gas arc. A four glower lamp consuming 352 watts would successfully replace 14-16 c.p. incandescent lamps or one six amp. a.c. enclosed arc lamp. A six glower lamp with a consumption of 528 watts is equivalent to 20-16 c. p. incandescent lamps, 1-7½ amp. a.c. arc or one 5 amp. d.c. arc lamp. All Nernst lamps were operated at 220 volts.

The depreciation in candle power amounts to about 22 per cent. in 1,000 hours and it is noted that after 300 hours run the c. p. remains practically constant, indicating that the Nernst lamp soon reaches a point in its life after which the further decline of the old glowers is just about counterbalanced by the addition of new glowers after burnouts occur.

There is a very slight decrease in wattage during the life of the glower, due to the gradual rise in resistance during its life. Before being used the glower presents a very smooth, white, chalk-like appearance. After having been in service for about 500 hours its surface becomes rough and crystalline in appearance, and it is probably this change that causes the increase in resistance, which amounts to about 5 per cent. in 500 hours. The average life of the glower when operating on 16,000 alternations is 800 hours; when operating on 7,200 alternations is 600 hours; when operating on 3,000 alternations is 350 hours.

The life of heater tubes and ballasts is not affected materially by the change in frequency.

The average life of heater tubes is 3,000 hours.
" " " " ballasts 15,000 "

Although the Nernst lamp properly belongs to the incandescent class, so far as maintenance is concerned it must be considered as an arc lamp, the lamp body, holder and globe corresponding to similar parts of an arc lamp, and from this similarity alone it seems evident that the maintenance of arc and Nernst systems is made the same. Lamps should be inspected periodically and holders containing burnt out glowers removed and replaced by holders with a full equipment of glowers, the old holders being allowed to accumulate until a sufficient number would justify the replacing of burnt out glowers. In fact, a well organized Nernst maintenance system would correspond very closely to an arc lamp maintenance department.

The Nernst lamp does not require any skilled labor for its maintenance unless a man or boy instructed as to the best and most economical method of looking after the lamp could be termed an expert. Even this does not necessarily infer that the labor should be expensive.

The Nernst lamp is particularly adapted for nearly all types of commercial illumination, and on account of the assortment of units it places at the disposal of the engineer an exceedingly flexible system which cannot be obtained in any other manner. We are all aware of the disastrous results, from an illuminating standpoint, obtained by using a combination of arc and incandescent lamps in the one interior. This will also apply to the very common habit of lighting by both gas mantles and incandescent lamps.

One of the last developments of the Nernst lamp is vertical glower series lamp for operation on either a 6.6 amp. or 7½ amp. a.c. series circuit. This lamp will fill a field which has long been vacant as a competitor with the Welsbach system of street lighting. Heretofore it has been necessary to compete by using either a 50 c.p. lamp at a higher price than gas or to reduce the amount of light given by using a 25 or 32 c. p. incandescent lamp. The Nernst series system is exceedingly simple, the heater and glower being mounted on one holder which is removed and replaced as one piece.

The watt consumption of the lamp including the loss in auxiliary transformer is approximately 115 watts, four of these lamps taking about the same energy as one standard a.c. series lamp. By using four of these lamps in place of one arc, the general illumination of a street would be greatly increased with practically no increase in consumption of energy. This type of lamp will appeal to the engineer who is desirous of laying out a scheme for the best illumination of suburban towns where dense foliage makes arc lamps impracticable.

The Italian Government is continuing its experiments with the use of the Stassano electric furnace for the production of iron and steel. According to the most recent data relating to the 150-kilowatt type of furnace, it is operated upon three-phase current, and uses about eighty volts at the terminals. The normal charge of the furnace is 1,000 pounds of material. This is made up of cast iron mixed with lime and iron ore in the proper proportions, also a small quantity of ferro-silicon or ferro-manganese. At present the furnaces are worked for the production of steel which is used in the manufacture of projectiles, and should contain 0.4 per cent. carbon, 0.03 phosphorus and 1.5 manganese. According to the most recent figures a furnace of this type will take from 1.1 to 1.3 kilowatt-hours per ton of steel. In a twenty-four-hour run, the furnace gives a yield of 2 6 tons. Three types of furnaces are now in use, having capacities of 750, 150 and 75 kilowatts respectively. As to the wear of the electrodes, this is stated to be twelve pounds per ton of steel. The refractory covering of the furnace needs to be renewed rather frequently, in general at the end of one month.

APPLICATION OF PHOTOMETRIC DATA TO INDOOR ILLUMINATION.*

By Ernest C. White, Illuminating Engineer, Winnipeg.

This paper calls attention to the somewhat troublesome methods in use for solving problems in illumination. These questions are generally decided by means of candlepower polar diagrams, curves which show the intensity of the light emitted in all directions. What the illuminating engineer wishes to know, however, is not the intensity of light emitted by a certain source, but what amount of illumination a certain source will give at a certain distance and in a certain direction. In order to obtain curves showing this feature, what are called uniform illumination curves are plotted—that is to say, a polar diagram showing the distance away in all directions from the source of light at which an equal illumination is obtained. These diagrams may be plotted for different types of lamps or lamps fitted with different types of reflectors,

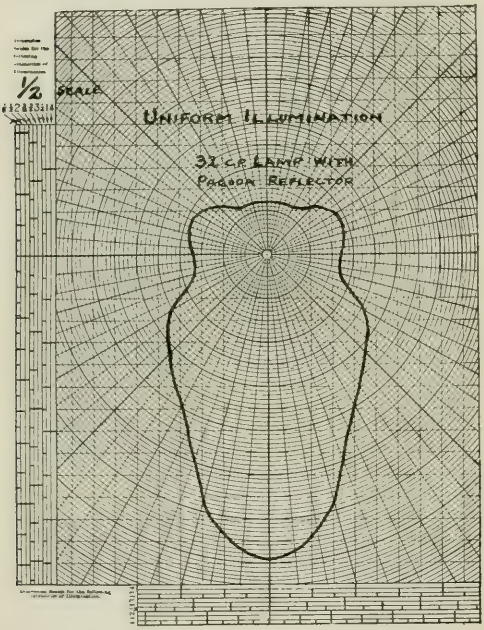


Fig. 1.—Polar Diagram of Uniform Illumination from an Incandescent Lamp.

one diagram of each kind being sufficient for lamps of all candle- powers. By means of a number of scales laid off at the side of the diagram and the concentric circles drawn on the diagram, it is easy to interpolate what distance away from the source of light a given illumination in candle-feet will be obtained in any direction. With a diagram of this kind for a given combination of lamp and reflector it is a simple matter to figure out from any assumed grouping of lamps the illumination in candle-feet which will be obtained at any point.

Fig. 1 represents the uniform illumination from a thirty-two-candle-power incandescent lamp with a pagoda reflector.

Each of the various scales is labeled in foot-candles, *i. e.*, each scale applies correctly to the curve for the intensity of illumination marked above it. Thus the illumination directly below the lamp will be one foot-candle at fourteen feet distance (*i. e.*, seven divisions on the one foot-candle scale equals fourteen feet, the curve being plotted to one-half scale); four foot-candles at seven feet distance; three-fourths foot-candle at sixteen feet distance; two foot-candles at ten feet distance; one-eighth foot-candle at forty feet distance, etc. In order to calculate illumination at an angle of forty-five degrees from the vertical, the radius of intersection is swung around to be a line paralled to the scales, the reading then being 0·5 foot-candle at nine feet distance, etc., if the rays are incident to the plane to be illuminated. If the plane in this case were horizontal, the horizontal and vertical rulings (provided on the co-ordinate paper to facilitate reference to the scales) easily permit of swinging a radius proportionate to 0.5 foot-candles illumination through the angle of incidence and thus reading with close approximation the actual illumination, which would be about 0.35 foot-candle at nine feet distance. Attention was called to several advantages that were thought to result from the use of these curves. The shape of the curve represents the effect produced, which is not the case with the ordinary polar distribution curve. The area of the curve is not so largly affected by the character of distribution as in the polar distribution curve. The curves of uniform illumination affords instant reference to the best location for lights—that is, the proportion of distance from ceilings and floors, the best angles for bracket lights, etc. The paper then showed the application of this method to fixture design, and pointed out that it is not extravagant to expend a good deal of careful calculation and thought on the design of a fixture when it costs from $200 to $300.

*Abstract of a paper presented before the Illuminating Engineering Society.

PERVERTED TECHNICALITIES.

What queer things the lay press sometimes says about electrical matters. A Yorkshire daily recently spoke of writing off a certain sum for "degenerators and transformers." A Dundee paper said that distribution charges would be "higher with 6,000 volts than with the present system." But a "Special" for the Daily Mail (Hull) excels in turgid gush anything that we have seen for a long time. It deals with the Hull Tramways power station.

"We must see how the mighty boilers are fed which work the stupendous engines." (300 kw.!). They are fed with coal by way of "troughs, at the bottom of which revolves a long screw, working on the same principle as the screw in a mincing machine" —how apt a similie!

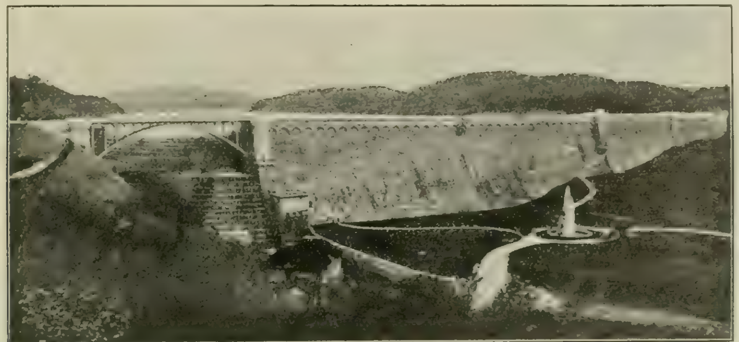
The dynamo is "to put it simply, in this case, a huge horseshoe magnet by means of which the electricity is generated"—apt again, you see; hence the horsepower! Next the armature: "The wonderful thing is that the revolutions of the copper-covered spindle of iron disks possess the power to intensify the electricity. By passing through coils round the magnet the electricity generated becomes more intensified still. By this time the electricity in the 'field' has reached 450 h.-p.; the 'field' is saturated, and can hold no more. Thus it comes about that the current finds itself passing along cables to a great switchboard, where it is distributed by a simple but ingenious contrivance to other cables, which convey it to certain sections of the tram system, from which it is poured into the rails themselves."—Electrical Review, London.

THE NEW CROTON DAM

The newest and greatest of the dams upon the Croton River, which is to impound 30,000,000,000 gallons of water for the consumption of the city of New York, is pronounced finished at last, after thirteen years occupied in its construction. The gates in the dam were closed some sixteen months ago, and since then, says Public Works, no water has flowed in the bed of the Croton below the new dam. It is doubtful, indeed, if any water will flow there henceforth, since the demands of the great city are much in excess of the average inflow of the Croton basin, and only in the rapid thawing of the snow in the early spring and the reultant freshet is there any great preponderance of supply over demand. In one such spring freshet day of 1905, however, there was an estimated inflow of 1,500,000,000 gallons and in three days the height of water in the reservoir rose to 14.48 ft. But the water in this new reservoir is the overflow from the spillways of about a dozen reservoirs higher up the Croton River and its tributaries, whose aggregate capacity is nearly 44,000,000,000 gallons. Two other dams and a diverting basin are under construction in the Croton watershed, which will add about 24,000,000,000 gallons to the storage capacity and will bring the total supply to about 102,000,000,000 gallons. This must suffice until the new water-source in the Catskill Mountains can be made available, which cannot be too soon accomplished, for the consumption of water by the city has reached the appalling daily average of 320,000,000 gallons. As the population of New York is growing with great rapidity, this consumption is sure to increase in like ratio, while the new works on the Croton have exhausted the capacity of that watershed.

The new Croton dam is a handsome work of solid heavy masonry, and has cost $7,631,189. Its completion makes possible some interesting comparisons with the great Wachusett dam which impounds a potential total of 63,000,000,000 gallons of the water of the Nashua River for the use of the metropolitan water district of Boston, Massachusetts. This latter work has been described quite fully in Public Works, both during its construction and soon after its completion last December. It will be seen that owing to the especially favorable location of the Wachusett dam its cost was much less, and the time expended in its construction was less than one-half that consumed in building the new Croton dam, though the capacity of the Wachusett reservoir is more than double that of the new Croton. The appended table gives the comparative figures:—

	Wachusett.	Croton.
Total length, dam and spillway (ft.)	1,496	2,168
Height, foundation to crest "	228.2	297
Width at base of foundation "	180	216
Width at crest "	25.75	18
Depth of foundation "	93	140
Height, ground level to crest "	107	157
Length of main dam "	971	1,168
Length of spillway "	452	1,000
Earth excavated in building (cub. yds.)	258,600	1,750,000
Rock "	99,350	425,000
Masonry in dam "	273,000	....
Storage capacity (million gallons)	63,000	30,000
Time of building	5 years	13 years
Cost	$2,173,159	$7,631,189



THE NEW CROTON DAM.
Its storage capacity is 30,000,000,000 gallons, and it has cost $7,631,189 to construct.

LEGAL.

Judgement has been delivered in favor of plaintiff in the case of King vs. Town of Palmerston, awarding $5,000 damages for the death of T. G. Burns, of Palmerston, who died from the shock of an electric wire, alleged to be due to a defect in the lighting system. Wm. King, the administrator of the estate, aked for $10,000.

The Halifax Electric Tramway Company hav e won a notable case in the Supreme Court before a jury. Dr. Mader, of that city, two years ago obtained a verdict awarding him about $7,000 for damages alleged to have been sustained while driving over snow thrown up from the company's tracks. After appeals had gone through the Supreme Courts of Nova Scotia and of Canada, a new trial was ordered, with the result now that the jury awards Dr. Mader no damages, but finds him negligent in his driving.

Judge Anglin, in deciding the cases of the Keewatin Power Company, brought against the Town of Kenora, declares that the power in all navigable rivers belongs to the Crown. The action was brought to restain the Town of Kenora from prosecuting expropriation proceedings in a branch of the East Winnipeg river. The eastern bank is owned by the Hudson Bay Company, the western bank by the Keewatin Power Company. The town of Kenora leased the bed of the river and proceeded to construct a dam for power purposes, and to expropriate land on either side for this purpose. The owners of the two banks claimed that their title was to midstream. Justice Anglin says: "By nothing short of an express grant should the Crown be held to have parted with its title to the alveus of our navigable rivers." The Crown grant gives title only to the water's edge. A natural obstruction in the course of an otherwise navigable river does not deprive the river of its navigable character. The case will probably go on to the privy council.

SCHOOL OF PRACTICAL SCIENCE EXCURSION.

The annual excursion and inspection trip of the School of Practical Science, Toronto, took place on Saturday, November 3rd. A special G. T. R. train of six coaches left the Union Station at 7 a. m. for Niagara Falls, carrying the members of the Faculty and about 300 students. The weather was fine, the arrangements perfect, and the day greatly enjoyed by

DR. GALBRAITH,
Principal School of Practical Science, Toronto.

all. Arriving at Niagara Falls about nine o'clock, the party were received by Mayor Slater and Mr. J. H. Jackson, City Engineer, and were taken by special cars, provided by the Toronto, Niagara & St. Catharines Railway, to Falls View, where a division was made into three sections and an inspection of the different power plants commenced.

The officials of the Ontario Power Company, Canadian Niagara Power Company and Electrical Development Company became for the time being the custodians of the students, who were shown through all departments of the gigantic plants by the assistant engineers. At the Ontario Power Company's plant, of which Mr. W. N. Ryerson is superintendent, the students found much to interest them. The power house, located at the foot of the Canadian falls, contains three Westinghouse generators of 10,000 h. p. in operation, a fourth of 12,000 h. p. in course of installation, while two more of 12,000 h. p. are on order and will be installed as quickly as possible. The proposed extension of the power house will also be undertaken immediately. This company is transmitting electric power to Syracuse, a distance of 162 miles, for the operation of the street railway there, and are also furnishing a large block of power to the Lackawana Steel Company, near Buffalo, replacing the gas engines previously used.

In the power house of the Canadian Niagara Power Company five generators of 10,000 h. p., built by the General Electric Company, are in operation. The engineering features of this plant were likewise of great interest to the students, but everybody had a natural curiosity to see the works of the Electrical Development Company, owing to the fact that this company will within a very short time be transmitting power to Toronto; in fact, a test of one of the wheels had been made but two days before. Here the installation consists of Canadian General Electric generators of 13,000 h. p. driven by I. P. Morris turbines. Some of the party, including the writer, had the privilege of making a trip through the tail-race tunnel, which was greatly appreciated. Those who have not visited the plants can form but little conception of the magnitude of the works that have been undertaken and the vast amount of capital required to carry them to completion.

The power plants and the carborundum and graphite works on the American side were also visited, where the students were received with equal courtesy.

In the afternoon a small party made a geological inspection of the Niagara Gorge, going from Niagara Falls, Ont., to Queenston Heights in a special car provided for the purpose. Stops were made at the Whirlpool and Foster's Flats and Queenston Heights. At the Whirlpool Dr. Coleman, Professor of Geology, gave a practical lesson in mountain climbing by leading the party down the bank to the water's edge and back again. Here he explained the origin of the Whirlpool and called attention to other features of geological interest.

At seven o'clock the entire party in a body dined at the Imperial Hotel, Mr. K. A. Mackenze, President of the Engineering Society, presiding. There was a short and informal toast list. "The King" and "The President of the United States" formed a joint toast, which was honored by singing the National Anthems. "Our Guests" was responded to by Messrs. N. R. Gibson, W. J. Larkworth and A. E. Davidson, of the

MR. K. A. MACKENZIE,
President Engineering Society School of Practical Science.

Hydraulic Power Company, and S. E. Thomson, of the Electrical Development Company, all graduates of the S. P. S. The concluding toast was that of "The Press", to which T. S. Young, of the CANADIAN ELECTRICAL NEWS, responded. Dr. Galbraith, Principal of the School, moved a vote of thanks to the officials of the various power companies for the courtesies shown to the party, which was heartily endorsed by the singing of "For They Are Jolly Good Fellows".

The Committee having charge of the arrangements consisted of Prof. C. H. C. Wright, representing the Faculty; Mr. K. A. Mackenzie, President of the Engineering Society; Mr. R. C. Ross, fourth year; Mr.

G. Wright, thrid year; Mr. J. Spence, second year; and Mr. R. G. L. Harston, first year. These gentlemen were unceasing in their efforts to provide for the pleasure and comfort of the party.

The School of Practical Science is making rapid progress. The total number of students in attendance this year is 620, of which 280 are first year. Notwithstanding the new building recently erected, the accommodation in certain departments is still inadquate, and the question of further extending the facilities will have to be again considered at an early date.

THE ECONOMICAL LIFE OF INCANDESCENT LAMPS.

The object of this article is to show the relation existing between the economical life of ordinary commercial carbon filament incandescent lamps and the price per unit for electrical energy.

It is evident that owing to the deterioration of illuminating value that takes place almost from the commencement of the life of an incandescent lamp, it would pay to scrap lamps at a very early age, were it not for the cost of renewals. When the average life curve of incandescent lamps is known, and the price of current and lamps is also given, it is a comparatively easy matter to calculate the correct point in the life of the lamps at which they should be renewed.

About a year ago the writer carried out a set of life tests on 48 200-volt 16-c.p. incandescent lamps of 12 different makes, four lamps being taken of each make. The lamps were all bought over the counter, and were, therefore, not in any way selected. The lamps were run at a mean pressure of 200 volts, but were subjected to the ordinary range of variations of voltage found on the Westminster Electric Supply Corporation's circuits. We may take it, therefore, that the average of all these 48 lamps represents fairly accurately a 200-volt 16-c.p. lamp of average quality, working under average conditions.

The test was carried on for 800 hours, but another 200 hours have been added to this by extending the curves. The following is the average life curve obtained for all 48 lamps taken together.

Hours run.	Candle-power.	Watts.	Watts per c.p.
0	16.7	59.8	3.58
100	15.9	60.6	3.81
200	15.05	59.8	3.98
300	14.35	59.25	4.13
400	13.7	58.8	4.29
500	13.15	58.5	4.45
600	12.65	58.2	4.60
700	12.25	58.0	4.725
800	11.85	57.8	4.88
900	11.55	57.6	5.00
1,000	11.3	57.4	5.08

From these figures the average candle-power and average watts per candle-power for various lengths of run have been calculated. The average works out as follows :—

Length of run.	Average candle-power.	Average watts per candle-power.
100 hours	16.3	3.695
200 "	15.9	3.79
300 "	15.5	3.875
400 "	15.15	3.96
500 "	14.8	4.04
600 "	14.5	4.12
700 "	14.2	4.195
800 "	13.9	4.27
900 "	13.7	4.345
1,000 "	13.5	4.41

Taking the cost of lamps as 10d. each, and current at 1d. per unit, the average cost per c.p.-hour for various lengths of run works out as follows :—

COST PER C.P.-HOUR IN PENCE.

Length of run.	Current.	Renewals.	Total.
100 hours	.003095d.	.00613d.	.009825d.
200 "	.00379d.	.00315d.	.00694d.
300 "	.003875d.	.00215d.	.006025d.
400 "	.00396d.	.00165d.	.00561d.
500 "	.00404d.	.00135d.	.00539d.
600 "	.00412d.	.00115d.	.00527d.
700 "	.004195d.	.00101d.	.005205d.
800 "	.00427d.	.00090d	.00517d.
900 "	.004345d.	.00081d.	.005155d.
1,000 "	.00441d.	.00074d.	.00515d.

From this table the cost per c.p.-hour for various prices per unit of electrical energy has been calculated, with the following results. The cost of the lamp has still been taken at 10d. each:—

TOTAL COST PER CANDLE-POWER-HOUR IN PENCE.

Price per unit : Hours' life.	1d.	2d.	3d.	4d.	5d.	6d.
100	.00982	.01352	.01721	.02091	.02463.	.02830
200	.00694	.01073	.01452	.01831	.02200	.02589
300	.00602	.00990	.01378	.01765	.02155	.02540
400	.00561	.00957	.01353	.01749	.02145	.02541
500	.00539	.00943	.01347	.01751	.02155	.02559
600	.00527	.00939	.01351	.01763	.02175	.02587
700	.00521	.00940	.01360	.01779	.02201	.02618
800	.00517	.00944	.01371	.01798	.02225	.02652
900	.005155	.00950	.01385	.01819	.02251	.02688
1,000	.00515	.00956	.01397	.01838	.02279	.02720

On plotting these figures in the form of curves, it will be seen that the correct scrapping points come out as follows :—

Price per unit.	Useful life.
1d.	1,000 hours.
2d.	650 "
3d.	500 "
4d.	450 "
5d.	400 "
6d.	350 "

All the above is intended to apply only to an average 200-volt 16 c.p. unselected incandescent lamp, run under average working conditions, and costing 10d.

If the price of the lamps is greater or less than 10d., if the quality of the filaments is superior or inferior to the average, or if the starting efficiency is not normal, or the pressure regulation differs from that obtained on the Westminster circuit, then the above figures will require some modification.

The useful life of a lamp is sometimes stated as the number of hours it runs before the candle-power drops 20 per cent. This occurs in the case of the average of these 48 lamps at 460 hours.—Lancelot W. Wild, in Electrical Review, London.

LIFE OF WOODEN POLES.

The German Postal and Telegraph Department has recently published statistics collected during a period of 52 years on the life of wooden posts impregnated with different preservative substances. The number of posts under observation amounted to nearly 3,000,000, and the following are the average results obtained:

Poles mipregnated with	Length of Life.
Sulphate of Copper....................	11.7 years.
Corrosive Sublimate..........	13.7 years.
Creosote..........	20.6 years.
Unimpregnated..........	7.7 years.

The manner of preparing the poles has been improved from time to time, and this is clearly shown in a further table giving the average length of life of the poles under different methods of treatment with each preservative at different periods. For example, in 1883, with sulphate of copper the average life was 9.4 years, while in 1903 the method of treatment had been improved so that an average life of 13.3 years could be obtained.

The Series Luminous Arc Rectifier System*

By N. R. Birge.

Central-station men are already familiar in a general way with recent developments in arc lighting both from papers read before various societies and from discussions printed in the technical press. The new luminous arc rectifier system which is the practical embodiment of these developments represents a great advance in the art of illumination. The energy economy, the brilliancy of illumination, and the character of distribution of the light are the marked advantages of this system.

The essential features of the new system are the luminous arc lamp (Figs. 1 and 2) with absolute cut-out on the line, and the mercury arc rectifier set in the station. The rectifier is supplied with alternating current and furnishes direct current to the lamps, which are designed to operate on direct-current circuits at four amperes with 75 to 80 volts at terminals.

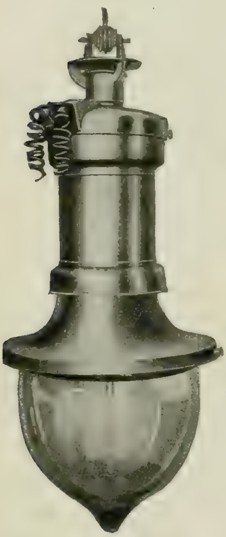


Fig. 1.—Luminous Arc Lamp Complete.

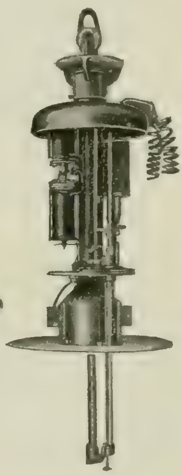


Fig. 2. Luminous Arc Lamp with Casing Removed.

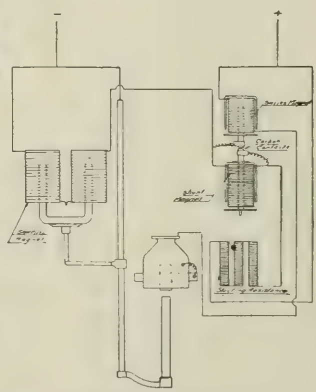


Fig. 3.—Connections of Series Luminous Arc Lamp.

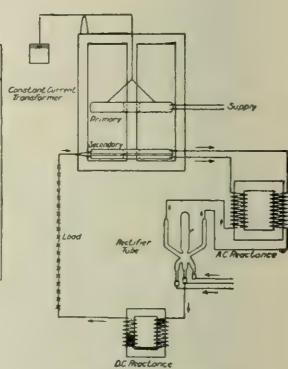


Fig. 4.—Connections of Series Arc Rectifier.

The Series Luminous Arc Rectifier System.

The Luminous Arc Lamp.

Construction.—The main frame of the lamp consists of a single large tube which acts as a chimney for carrying away the fumes of the arc. At the top of the lamp are wind shields which prevent downward drafts into the tube.

The electrodes of the luminous arc lamp differ entirely from ordinary carbon arc-lamp electrodes. The upper electrode consists of a bar of hard drawn copper supported by iron wings. The lower electrode is made of specially prepared composition contained in an iron tube ⅝ inch in diameter by 8 inches long.

A horizontal reflector is placed inside the globe and in close proximity to the arc and serves to throw an ample volume of light before the lamp without interfering with the main distribution of light in the horizontal direction. (See Fig. 2.)

The casing is made of solid copper with oxidized finish and supports a closed base outer globe (Fig. 1), the lower part of which is frosted to ensure an even distribution of the light directly beneath the lamp.

Operation.—Referring to Fig. 3, the operation of the lamp is as follows:

The mechanism is without floating parts and when the lamp is out of circuit its electrodes are separated with the lower electrode carrier detained by a stop which holds the tip of the lower electrode at a fixed distance from the upper electrode. When the current is thrown on, the pickup by the starting magnet brings the lower electrode into contact with the upper electrode. This operation allows the current to flow through the series magnet, thereby opening the circuit of the starting magnet at the cut-out contact, allowing the lower electrode to fall, striking an arc. The lamp is then burning with the lower electrode carrier resting on its stop and with the series magnet holding the cut-out contact open. As the lower electrode is consumed the voltage across the arc rises, the shunt magnet (which is bridged across the arc) lifts its armature, closing the cut-out contact when the arc voltage has reached a predetermined limit. The closing of this contact cuts the starting magnet again into circuit, thereby picking up the lower electrode and starting the arc as before with the correct length of arc for proper operation.

The series magnet is of low resistance and causes a drop of only a volt or two between the terminals of the lamp and arc when the lamp is in operation. The lamp is so designed that only two single adjustments are necessary: the adjustment of the shunt armature to feed the lamp at the proper arc voltage, and the

* Paper read before the Ohio Electric Light Association.

setting of the stop for the lower clutch to determine the proper length of arc.

The switch which has been ordinarily used with series lamp has been omitted, as it has become common practice to install an absolute cut-out with each series lamp, thus making a lamp switch unnecessary.

Advantages of the Luminous Arc Lamp. — The luminous arc lamp possesses qualities of such importance that its introduction undoubtedly means a revolution in street lighting. This lamp is superior to other lamps used for commercial purposes in respect to efficiency, distribution of light, color of light and low maintenance cost. Its principal feature is its high efficiency, which even without its other advantages would undoubtedly soon establish for this lamp an important position in street lighting.

Efficiency.—Readings made with the luminometer show that a luminous lamp consuming 310 watts at the terminals gives the same intensity of illumination at a distance of 309 feet that the 480-watt direct-current series enclosed arc lamp gives at a distance of 275 feet and that the 480-watt alternating-current enclosed series lamp gives at 247 feet.

Distribution.—In the direct-current open-carbon arc the positive (upper) carbon forms a crater of small area which emits over 90 per cent. of the light. The axis of maximum light distribution is at an angle of about 45 degrees with the horizontal, and the intrinsic brilliancy is unduly high. The well-known disadvantages of the open arc are:

1. Poor diffusion resulting in the casting of hard black shadows from nearby objects.

2. Wide variation in illumination due to the wandering of the arc.

3. Intense illumination in the vicinity of the lamp with greatly decreased illumination at the light intersecting point between poles.

The enclosed arc lamp effects considerable improvement in these particulars. Its distribution and diffusion of the light are better because of the longer arc and the blunter ends of the carbon points.

The luminious arc lamp, however, effects still greater improvement by the possession of qualities of distribution and diffusion that render this lamp ideal for street lighting. All the light comes from the arc which is exceedingly long, a feature which gives a nearly horizontal axis of maximum distribution and at the same time eliminates heavy shadows and contrasts. Moreover, the maximum and minimum luminometer readings differ but slightly, for the eloctrodes offer practically no obstruction to the light and the distribution is not disturbed by the wandering of the arc.

Color.— The color of the luminous arc light is pleasant for street illumination. The light has a spectrum which is practically the same as that of sunlight and as white as any artificial light in commercial service to-day.

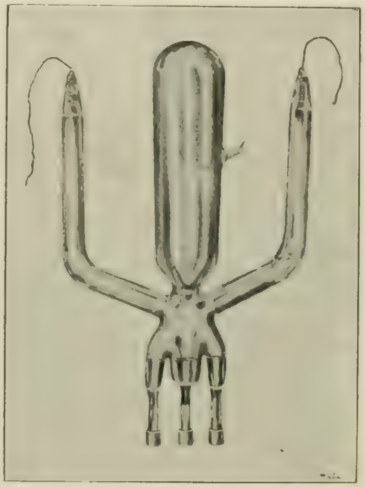
Low Maintenance Cost.—The maintenance cost of the luminous arc lamp is very low. The upper electrode is copper and the arc burns at a comparatively low temperature, which results in an average life of about 4,500 hours for this electrode and a practically negligible cost for renewal. The lower electrode has a burning life of 150 to 175 hours, which allows one man to take care of and trim a much greater number of lamps than is possible with open or enclosed carbon arc lamps. This long burning feature and the fact that only one electrode must be renewed gives marked economy in maintenance.

The Series Rectifier Outfit.

The station end of the series luminous arc rectifier system includes a constant current transformer connected to the alternating-current source and the series mercury are rectifier panel with its accessories.

Constant-Current Transformer. — The constant-current transformers used with the rectifier outfit have the same general appearance and characteristics as those used with the series alternating arc-lighting system.

The primary windings of the transformer (see Fig. 4) are connected to an alternating current supply of practically any voltage. The secondaries are connected



Series Mercury Arc Rectifier.

through small reactances to the anodes or alternating-current terminals of the rectifier tube. A tap at the middle of the secondary connects the transformer with one end of the direct-current circuit on which the lamps operate.

The proper adjustment for current in the lighting circuit is obtained by small weights attached to the rocker arms which support the movable coils of the transformer. The transformer will regulate from full load to slightly below one-half load with constant secondary current.

The constant current transformers for outfits of under 50 lights capacity are air cooled, while the 50-light and larger sizes are oil cooled.

Reactances.—The small reactive coils already referred to are enclosed in a common case and protect the secondary from inductive kicks or high-frequency oscillations which may be caused by disturbances on the line circuit.

Another reactive coil is inserted in the direct-current side of the rectifier circuit in series with the lamps in order to reduce the pulsations of the rectified circuit.

Rectifier Tube.—The rectifier tube is the means by which the alternating constant current is changed to direct current for the series circuit. It consists of an exhausted glass vessel containing one carbon anode or positive terminal in each of the two upper side

arms, two mercury starting anodes and the mercury cathode or negative terminal at the bottom of the tube.

The rectifier tube is supported on the panel in a movable wooden holder. The tube is put into operation by shaking it slightly, which causes a flow of mercury between the mercury starting anodes and the mercury cathode, thereby bridging the circuit and permitting a flow of current from the low voltage exciting circuit connected to the starting electrodes. The breaking of this bridge causes the formation of a small arc at the bottom of the tube between the starting anodes and the cathode. With this small arc in operation the main arc can be established by closing the primary switch of the constant-current transformer, which throws the secondary of the transformer in circuit with the operating anodes of the tube.

With the tube operating at four amperes there is a drop equivalent to about 25 volts or a loss of 100 watts which is constant at all loads. Under normal operating conditions the average life of the tubes on 25, 50 and 75-light circuits is over 400 hours. Reports from commercial installations show that the maximum life reported is over 1,200 hours. Following is a quotation from a paper read by W.S. Barstow before the National Electric Light Association at its convention held at Atlantic City in June, 1906:

"There have now been in operation in Portland for several months over 800 lamps with rectifiers, and the installation is being rapidly increased as fast as deliveries can be made. The system has proved successful and has fulfilled expectations. Considerable difficulty in the form of static discharges and short life was at first experienced with the tubes. The tubes, which were of small size, were subjected to very rigid requirements on account of the alternating-current pressure of 18,000 volts, a pressure which was very much higher than anything yet attempted with mercury arc rectifiers. The tubes have now averaged over 650 hours and several have exceeded 730 hours, 500 hours being the economical requirement, and anything above this being in the nature of a gain in the original calculated efficiency of the system."

Capacity.—The standard sets are designed for 12,25 and 50 lights, although outfits of larger capacity can be furnished if required.

Frequency.—One of the most important advantages in connection will this system is the readiness with which it can be adapted to circuits of any frequency from 25 to 140 cycles. The standard sets are designed for 60 cycles, but outfits have been designed for and are in operation on circuits of 25, 33 and 40 cycles.

Efficiency and Power Factor.—The efficiency of the rectifier sets when operated at full load with rate primary voltage and frequency varies from 85 to 90 per cent. depending upon the capacity of the set. Under the same conditions the power factor varies from 65 to 70 per cent.

Switchboards.—The switchboard consists of a single piece of blue Vermont marble 62 by 24 by 2 inches, supported on a pipe frame eight feet high. These boards are designed for installation immediately in front of the constant-current transformer and are not a portion of a complete switchboard.

The following equipment is mounted on each board: One mercury rectifier tube, one tube holder, one handle for starting tube, one ammeter in protecing case, two open-circuiting plug switches, one short-circuiting plug switch, two primary plug switches (double-throw switces are furnished with 50 light sets), one starting switch, one blower motor switch.

Blower.—A blower for cooling the rectifier tubes is furnished with each set. This blower is direct-connected to a small horsepower motor operated from either a single-phase or a three-phase circuit. If several sets are installed, one larger blower with the proper system of distributing the air can be used for cooling all the tubes.

Installation.—The series rectifier system was first introduced about one year ago, and since its introduction orders have been received for over 80 sets with a total capacity of 4,500 luminous arc lamps, the largest installation being at Portland, Ore., where a system of 1,200 lights capacity has recently been installed.

MONTREAL

Branch Office of The Canadian Electrical News,
Room B34 Board of Trade Building.

November 3, 1906.

The rapid and continued rise in copper is apt to prove a serious question in Montreal. Some very heavy contracts have been taken in both in-door and out-door wiring, and although some of the better contractors are protected in the shape of a yearly contract with the manufacturers, yet it is a question whether this protection will be of benefit if, as seems likely, the manufacturers will not be able to buy copper at all for love or money. It is high time some Canadians took an interest in providing us with some of our own copper, as it looks very much as if the hold-up was caused by the American syndicate.

The Dominion Burglary & Guarantee Company are building new and handsome quarters on St. James street west, near Victoria Square. The building will be of fire-proof construction, and the contract for wiring, which is in iron conduit, has been awarded to Mr. P. Lahee.

As a better price can now be had for the old copper wire on the poles, which has done service for several years, than what it cost originally when it was put up, some of these ornamental circuits ending in nowhere are being rapidly taken down.

The Quebec provincial tax on foreign travellers is just about beginning to be felt now as a first-class nuisance. There is hardly one electrical firm in Montreal who has a good word to say for it, as in many instances travellers have simply stopped coming here, and we get out of touch with the latest quotations of the American market. The bill is what may certainly be termed "petty politics in the extreme."

Engine vibrations have been overcome by a special foundation built for a 20 h. p. gas engine driving a 12½ k. w. lighting dynamo in a London house. The foundation consists of a 5-in. bed of concrete on which were laid ten 3 x 4½-in. timbers, spaced 6 in. apart. A series of 2-in. holes were bored in the top of each timber, and in these holes were inserted powerful helical springs, capable of carrying 500 lbs. with ½-in. compression, there being forty-eight springs in all. These springs support a galvanized-iron tray, 10 ft. long by 5 ft. wide, which contains a concrete base, 2 ft. 8 in. thick, upon which the engine is erected. The exhust and compressed air connections to the engine are of flexible metallic tubing, while all other piping connections are made through rubber hose. When the engine was started on this foundation, it was found that the vibration had been eliminated, but a slight longitudinal swaying of the engine was noticed at first. This vibration was prevented by locating a timber guide at either end of the spring supported platform, since which the outfit is said to have operated absolutely without noise. This is a simple and easily-constructed form of cushioned foundation, but has the disadvantage that it is applicable to comparatively small units only.

TORONTO BRANCH A. I. E. E.

The opening meeting for the season of the Toronto Branch of the American Institute of Electrical Engineers was held at the Engineers' Club rooms, 96 King street west, Friday evening, November 9th. The attendance of members and visitors numbered upwards of sixty. The President, Mr. R. G. Black, presided, while Mr. Louis W. Pratt, who has recently removed to Toronto from Brantford, discharged the duties of Secretary. The President spoke very hopefully of the outlook for the Branch and some very interesting papers are expected during the season.

The paper of the evening was entitled "The Nernst Lamp," the author being Mr. A. E. Fleming, who is well known as the Nernst lamp expert in Canada.

Mr. Fleming was unable to be present, having been called to Pittsburg, but his paper was presented in a very interesting manner by Mr. G. C. Keyes. The various parts of the Nernst lamp were exhibited for examination,and Mr. Keyes was called upon to answer numerous questions regarding its construction and operation. At the conclusion of the discussion he was tendered a hearty vote of thanks.

ACCIDENTS IN POWER HOUSE OPERATION.

We often hear of accidents that occur to the operators or apparatus in central stations.

We are naturally more or less interested in knowing the cause or reason for these accidents. Investigation has shown that about ninety per cent. of the accidents are caused by carelessness on the part of the operator or an assistant. Many ingenious devices have been designed to overcome carelessness on the part of operators, such as interlocks, tell-tales, and so forth.

It is the intention of the designing engineer to make power house apparatus as fool-proof as possible. Yet with as many safe-guards as can be thought of operators sooner or later become careless and accidents are generally the result, often causing severe strains to be thrown on apparatus, which sometimes lead to serious trouble.

In a certain power house the generators were connected to water weeels, and in order to bring the generators to a stop it was the custom of the operator to short-circuit the terminals by means of a piece of cable after the water valves had been closed. This was done because the valves leaked enough to keep the water wheels turning, but after being brought to a stop the leakage pressure was not enough to start them. The operator in this instance, through carelessness or forgetfulness, short-circuited a unit that was running at full voltage, and which was "cut in" on the bus bars. This unhappily resulted in the loss of the actendant's life as well as causing a considerable amount of damage to the electrical apparatus throughout the station.

There have also been a number of cases in which trouble has resulted because the operator took some one's word that things were all right. This is a bad policy,and if possible everything should be checked over when any undertaking is in hand. When new apparatus is installed and is about to be started those who have been assisting in the work will often state positively that all connections have been properly made. In many cases this has proven to be incorrect and the result in some instances has been loss of time and suspension of service together with a severe strain on the apparatus.

Lack of technical knowledge has been a considerable drawback to many operators. Operators who have started in as oilers and have been promoted to electrical attendants have been taught and have also learned by observation that by closing certain switches they could obtain certain results. As long as everything runs smoothly such men are very satisfactory attendants. But if something out of the usual takes place they are in most cases helpless and often cause additional trouble by mistakes they make while attempting to correct trouble.

There was one case in which the installation of some 250 k. w., 60 cycle generators direct-connected to water wheels was left to a man who claimed that he was well versed in this class of work. The machines were stored in the power house and subjected to more or less moisture. After being erected and started up they could apparently be raised to only half voltage. A load was thrown on, however, and an attempt made to raise the voltage by speeding up the water wheel. Then the insulator broke down between phases, resulting in the burning out of one-third of the winding.

The second machine was put through the same operation, and the instrument transformer burned out. This put an end to the experiments until the company manufacturing the apparatus could be communicated with. Investigation showed that the transformer voltmeter was connected up for the wrong ratio and the voltmeter was reading only one-half of the true voltage of the generator.

An amusing incident which will illustrate the lack of knowledge on the part of an operator, and also give an idea of the class of men sometimes found handling electrical apparatus, occurred a short time age. Several sub-stations containing oil-cooled transformers were installed in connection with a high tension transmission line. One of the operators who had just been placed in charge of one of these sub-stations called up the erecting engineer and requested that he come at once to the sub-station and remove some frogs that had gotton into the transformers. Upon being asked how he knew there were frogs in the transformers, he innocently replied that anybody who know anything at all could tell by the bubbles coming to the surface of the oil.

Such are the men to whose tender mercies power house apparatus is somtimes intrusted. But it is through carelessness rather than ignorance that trouble usually comes. Intelligent care and common sense are the elements most needed in the handling of electrical machinery.—H. Gilliam, in The Electrical Journal.

The De La Vergne Machine Company, foot of East 138th street, New York City, has just issued a folder describing the Klein water cooling tower built by them. These towers will cool the water to from 5 t6 15 degrees below the temperature of the atmosphere.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Question No. 1.—Will you kindly explain to me the principle upon which the hydraulic ram works, and where it finds its application.

Answer.—The hydraulic ram is a machine which has been in use for a great many years, the principle of its operation having been discovered by Whitehurst in 1772, but the device at that time was of course very crude. It was later perfected by Montgolfier in 1796, from which time the design has been steadily improved and the application greatly increased. The general use of the ram is in locations where a low fall of water is obtainable, and where it is desirable to elevate a portion of this water to a greater height than the original source. The principle of the ram is the employment of the dynamic pressure produced by stopping a column of moving water to raise a portion of such water to a high level. The ram consists of what is known as a drive pipe, which, as a general rule, is never less than 15 ft. in length and should not have a fall of less than 1½ ft. The end of this drive pipe discharges through a check valve into an air chamber, out of the bottom of which the delivery pipe is taken and run to a point at the desired height. In the drive pipe, close to the point where it enters the reservoir, a waste valve is placed, which closes in such a way as to cut off the flow of water from the drive pipe into the waste pipe. This waste valve is so arranged by counterbalancing that the pressure due to the static head of water in the drive pipe is not sufficient to keep it closed. The operation of the ram, therefore, is as follows: The waste valve is open, and water flows down through the drive pipe from the reservoir, and discharges through the waste valve until the speed of such water is sufficient to make the waste valve close. The momentum of the water in the drive pipe produces a very great pressure on the waste valve, and holds same tightly against its seat. The water must necessarily find some outlet, and it therefore passes through the check valve into the air chamber, producing a great pressure in this receptacle, which subsequently drives the water through the delivery pipe up to the point of desired elevation. As soon as the water in the drive pipe comes to rest, the only force holding the waste valve closed is that due to the static head, and, as before stated, this valve is so counterbalanced that this head is not sufficient to keep it closed. It therefore opens and allows the water to flow through the drive pipe into the waste pipe, until again such speed is reached as to make the waste valve close, the water then driving into the air chamber in the same way as previously described. It is customary to make the area of the delivery pipe about one quarter that of the drive pipe, and data is available which shows that with a fall of 10 ft. water can be forced very nearly to a height of 150 ft., though, of course, the volume of such water will be small compared to the amount which comes down the drive line. Some manufacturers are prepared to guarantee that their rams will deliver one seventh of the total water coming down the drive pipe to a height five times that of the fall. This, of course, is under certain fixed conditions, one of which is the length of the drive pipe. The longer this pipe, the higher of course will be the elevation to which water can be forced.

Question No. 2.—Could you inform us if there are any towns in Canada that are using 125 to 133 cycles alternating current.

Answer.—Up till recent years, almost all the towns requiring but small plants were 133 cycles. The great majority of these have been recently enlarged, and it has been the almost invariable practice to change over to 60 cycles. We cannot furnish you with a complete list of plants which have not been so changed over, but would refer you to the publication covering electrical plants in the United States and Canada issued by the Street Railway Journal. From this you will be able to get full information covering practically every plant in Canada, such as the size and make of generators used, the frequency, the voltage, number of phases, etc.

Question No. 3.—Will you kindly give me some figures pertaining to the use of aluminum wires as electric conductors for transmission work.

Answer.—In practically all cases where the installation of aluminum is permissible, the conductors are made in the form of a cable, under which circumstance a given cross section of metal has a greater flexibility and a greater strength than solid wire with an equivalent cross section. Copper weighs approximately three and one third times more than aluminum, but the conductivity of aluminum is only 63% of a copper wire having an equal cross sectional area, and therefore an aluminum wire or cable, to have the same conductivity as any certain size of copper wire, must have a cross sectional area 1.6 times as great. Considering this matter of conductivity and weight, you will see from the above figures that the weight of an aluminum wire of equal conductivity will only be 48% of the weight of a copper conductor of similar conductivity, or approximately one half. Therefore, if copper costs twenty cents per pound, and aluminum can be purchased at forty cents per pound, the cost of the two metals at the point of manufacture will be identical for the same carrying capacity. You must, however, give consideration to the question of freight, if you are thinking of shipping any quantity of either metal to some distant point. The aluminum is only one half the weight of the copper, and therefore a saving can certainly be made in favor of this metal. On the other hand, it is probable that the railway companies will charge a slightly higher freight rate per 100 pounds for aluminum than they charge for copper, owing to the fact that for a given weight the aluminum will take up more car space. The matter of making joints in aluminum conductors was for some time a serious difficulty, but the use of the aluminum sleeve and a twist joint has now overcome this trouble in an entirely satisfactory way.

THE LATE W. T. JENNINGS, C. E.

Mr. William T. Jennings, of Toronto, the widely known consulting engineer, died of paralysis at Lansing, Mich., on Wednesday, October 24th. He was in Lansing inspecting the lines of the Michigan United Railways, and was a guest of Mr. J. R. Elliott, manager of that road, when his death occurred. Mr. Jennings was one of the best known civil engineers on the American continent. His experience began on the old Great Western Railroad. During the construction of the Canadian Pacific Railway, he had charge of section B, with headquarters at Rat Portage (now Kenora). Afterwards he was given charge of a section stretching eastward from the Pacific coast 350 miles, a piece of work requiring great engineering skill, but which was successfully completed.

On the completion of the road, Mr. Jennings was appointed chief resident engineer of the western division, with headquarters at Toronto. He held this position until 1890, when he resigned to become city engineer of Toronto. This position he resigned two years later to engage in a consulting practice. He built the Niagara Falls Park and River Railway and the Galt, Preston & Hespeler Electric Railway, and was chief engineer for the famous Crow's Nest Pass Railway. He made reports on several important Government works, such as the Halifax and Esquimault docks. At the time of his death he was preparing a report on the Louise Basin at Quebec.

For the past to years Mr. Jennings had been engaged in connection with the transmission line and electric railway of the Toronto and Niagara Power Company between Niagara Falls and Toronto.

Mr. Jennings was a member of the Institute of Civil Engineers and the Engineers' Club of Toronto, Past President of the Canadian Society of Civil Engineers, and an honorary examiner of the School of Practical Science.

Mr. Jennings had reached the age of sixty. He was born in Toronto, a son of Rev. Dr. Jennings, for many years minister of the old Bay Street Presbyterian church, and was educated at Upper Canada College. One son, Gorden T. Jennings, survives him. His wife predeceased him by several years. It is said of Mr. Jennings that none lived up to a higher sense of professional honor than he.

The Late W. T. Jennings, C. E.

TORONTO RAILWAY ENGINEERS' CLUB.

A meeting was held at the King Edward Hotel, Toronto, last month with the object of establishing a club for railway engineers similar to the railway clubs existing in the leading centres in the United States. Mr. F. H. Burroughs, of Belleville, occupied the chair. It was decided to appoint a strong committee to draft a constitution and by-laws.

There is no limit to the business that can be created by good advertising in the right mediums at the right time.—Printers' Ink.

RECENT INCANDESCENT LIGHTING PROGRESS

Since the commercial production of the single-phase railway motor the most striking advance in the electrical field has certainly been made by that most familiar of all electrical appliances—the incandescent lamp. The recent production of 50-watt metalized filament lamps having an efficiency of 2.5 watts per candle power (mean horizontal) and useful life of 500 hours marks a notable step forward, for, valuable as the higher candle-powered high-efficiency units are in the large illumination work of the present day, it remains for the ordinary 16 to 20-candle-power lamp to meet the requirements in the great majority of installations.

In a paper on "Recent Incandescent Lamp Improvements" presented in September before the Vermont Electrical Association at St. Johnsbury, Mr. Francis W. Willcox, of the General Electric Company, pointed out a number of significant signs of the times in the lighting field. By reason of its great simplicity, moderate cost, ability to withstand the most abusive conditions as to surroundings, divisibility into small units, noiselessness of operation, reliability and aesthetic attractiveness, the incandescent lamp is almost an ideal piece of apparatus. In the average case it will certainly have the preference for illuminating work at equal or better efficiency, and with the recent progress in economy for a given production of light, we can expect the proportion of central station income from incandescent service will be materially augmented, the field widened and the volume of business greatly increased. The investment required for arc lamps is relatively high; small units are unsatisfactory; the limit of frequency is about 40 cycles, and for a. c. and d. c. circuits two types of lamps are required. Even the Nernst lamp is available for alternating current only, in this country. The numerous moving parts of the arc lamp require attention and adjustment while in service, which is of course not the case with the incandescent.

The prices of high-efficiency lamps complete with reflectors are now sufficiently low to bring the renewal costs about on a parity with those of the old 3.5 or 3.1-watt lamp, hence these lamps can be supplied on the same liberal free renewal basis as ordinary lamps, and many companies have adopted the policy with advantage. In the efforts to improve the distribution of light by the use of scientifically designed reflectors —and this is quite as important as the production of more efficient filaments—a new Holophane "Bowl Reflector" has been brought out, which gives uniform illumination over an area equal in diameter to 1.5 times the height of the lamp above it, giving a distance between lamps for uniform lighting of 2.5 times the height. Results like these are nearly ideal, as the curve of distribution corresponds very nearly to the perfect curve of uniform illumination. In comparison with the 50-watt lamp of 3.1-watt efficiency, the new 50-watt, 2.5 watt efficiency lamp shows a gain of 20 per cent. in economy and of 350 per cent. in life for the same efficiency. One must consider the long years of painstaking, plodding work required to increase the useful life of the old carbon filament 100 hours, or about 25 or 30 per cent., to realize what progress the new filament has made. In the case of series lamps of low voltage the improvement in life for the same efficiency is about 500 per cent. With such a gain—practically 1 watt per candle-power for equal life—the high-efficiency series lamp should be able to compete on very favorable terms with the Welsbach, which is such a serious competitor for suburban street lighting, on account of the better value of small and more frequently placed units of light for this class of service.

In the case of the tantalum lamp, the change of resistance with respect to change of voltage gives a more favorable condition than for the ordinary carbon filament in respect to the effects of fluctuating voltage upon candle-power and life. It requires nearly twice the per cent change in voltage on the tantalum that it does for the carbon filament, to produce the same change in candle-power. The tantalum lamp has a useful life of about 700 hours on direct current, but only about 200 on alternating circuits. It does not seem possible to reduce the size much below 22 candle-power without a sacrifice of efficiency below 2 watts per candle. Thus the 16 candle-power lamp of tantalum filament has an efficiency of about 2.25 watts. The lamp burns to best advantage with a suitable reflector, and in a pendant position. It has a useful life 40 per cent. longer than the 3.1 or 2.5-watt filaments, on d.c. circuits, costs about three times as much as the 3.1 lamp, 2.4 times as much as the 2.5-watt lamp, or about 50 cents net, dating from September 1. Unfortunately it is somewhat fragile, and suffers from vibration. Even with this slight disadvantage, it should compete with a Welsbach mantle, if the price of the present incandescent lamp is allowed toward a new tantalum.

Mr. Wilcox did not discuss the new tungsten lamp at St. Johnsbury, and in view of the announcement that this lamp is new on the market, it should not be overlooked in considering the latest progress in the incandescent field. It is reasonable to expect an efficiency of from 1.5 to 2 watts per candle-power with the tungsten filament, although a number of points remain to be definitely determined by commercial experience with this type of lamp. It is something of a question just how well the tungsten lamp will work on both a. c. and d. c. circuits. The most suitable candle-power for various efficiencies are as yet undetermined in the minds of lamp users, but if reasonable first cost and life can be guaranteed, there is little doubt that the ordinary carbon filament will be generally superseded, particularly as tungsten is not one of the specially rare elements. Whether central stations are disposed to supply their customers with high-efficiency lamps or not, the consumer will certainly procure them sooner or later, so that there is little to be gained in refusing to follow the epoch-making advances of the past two years.

A great deal of misunderstanding has occurred in certain central stations in connection with the introduction of high-efficiency lamps. There has been a fear expressed in some quarters that the central station business would suffer by the adoption of improvements which primarily benefit the consumer. A broader view than this should obtain. The central station does not

give the consumer more electrical energy for the same money by adopting the high-efficiency lamp; it simply gives him more and better light for the same monthly bill. It is often hard for a central station man to realize that light is what his customers desire, instead of so many kilowatt-hours by the meter. Then, too, the new lamps cannot be turned out fast enough to demoralize existing conditions. The slightly increased cost is a small matter in the face of the increase of business which ought to follow the late improvements in incandescent lamp designs. There is no need to wait for still further advances before taking hold of present gains, for the incandescent lamp is a relatively short-lived piece of apparatus.—Electrical Age.

THE EFFECT OF THE HIGH-EFFICIENCY INCANDESCENT LAMP.

There seems to be some misapprehension in certain quarters as to the effect that may be produced by the successful development of a highly efficient incandescent lamp. Fears are sometimes expressed that, if such lamps as the tantalum come into general use, or if some form of tungsten lamp shows such good results in practice as the laboratory tests foreshadow, the effect will be very gratifying to the consumer, but far from satisfactory for the supplier of electrical energy. This idea is due no doubt, says The Electrician, to the fact that the charge made to the consumer is for power, not for light, and consequently, if the power for a given amount of light is reduced by a more efficient lamp the charge becomes less.

That such fears are groundless may be seen most readily by referring to the analogous case of the incandescent gas mantle. The position of the gas companies would certainly not have been so prosperous as it is at present but for the advent of the mantle. The competition of the electric light would have been felt much more keenly. No doubt for the same amount of light less gas has been used, but the business of the gas companies has nevertheless increased, and the fact that one of them recently supported the defendant in a gas mantle infringement case is an indication that they have no wish to restrict the free use of economical devices for gas lighting.

There is still a popular tendency to look upon the suppliers of electrical energy as concerned with light alone, whereas the supply of power is now an important part of the business, and increasingly so. The more important this branch becomes the less will the whole output be affected by any falling off in the demand through the use of more economical devices.

Apart from the question of present consumers, there is the important one of competing with the gas companies for consumers in the future. Here the high-efficiency lamp will prove an important factor in influencing a certain class to whom the other advantages of electric light may not appeal sufficiently to induce a change from the gas mantle.

But it is not unlikely that the competitive value of the high-efficiency lamp will be more apparent in street lighting than in any other line. At present the flame arc lamp can hold its own against the various forms of gas lighting; but the great majority of thoroughfares are not sufficiently important to warrant the cost of arc lighting, and are sufficiently illuminated by low-pressure gas and incandescent mantles. These produce a fair illumination, the light being given at points which are closer together than would be possible commercially with arc lamps, and consequently with a less "spotty" effect. The ordinary glow lamp has been found to be too costly from the energy point of view for this kind of work; but if a really high efficiency metallic filament lamp, running at 1 to 1½ watts per candle, were put upon the market, there is no reason why the lighting of such thoroughfares should not be effected electrically as cheaply as with gas, and without the disadvantage of the frequent renewals which are necessary with the mantle.

It may, therefore, be fairly concluded that the advent of the high-efficiency lamp will not cause any decrease of the load on electricity generating stations. There might possibly be a somewhat less rapid increase in the output than has been the case in recent years, but even a falling off of that kind is improbable for some years to come.

There is one rather important point that must be borne in mind in considering this question, and that is the minimum candle-power that is obtainable commercially. For a great many purposes an 8 c.p. lamp gives all the light that is required, and when that is insufficient a more pleasing effect is obtained by using three lamps of 8 c.p. than one of 24 c.p. Where the 8 c.p. lamp is not powerful enough the 16 c.p. lamp, singly or in groups, is usually to be preferred to lamps of higher power. Generally speaking, the more subdivided the light the more pleasing is the effect, and if the light could be so far subdivided as to be spread over the whole of the ceiling efficiently the result would be ideal. Now, the higher the efficiency of a filament lamp the greater is the difficulty of making a lamp of low candle-power, the more so that the tendency is to use the highest pressures permissible for supply. This difficulty is apparent, for example, in the Nernst lamp, in which filaments for less than a quarter of an ampere have not been made commercially. On low pressures this size gives a comparatively low candle-power, but the effect of the ends of the filament reduces the efficiency, and on higher pressures the candle-power becomes proportionately increased. In metal filament lamps it is difficult to get the metal so finely drawn as to give the required resistance in the necessarily short length, and therefore such lamps for a pressure of 220 volts are likely to give not less than 50 to 60 candles. It follows, therefore, since the high-efficiency lamp is likley to be of a considerably higher candle-power than those in general use, that there will be no rapid replacement of the carbon lamp. When much light is required high-efficiency lamps will no doubt be used, and the energy consumed will be reduced, but in those cases where the light required is small the carbon lamp will remain; or if it is replaced the light will be increased, and the energy consumed will not be much affected. Quite apart from these reasons, however, human inertia will prevent anything in the way of a rapid change.

People get rich knowing to-day what somebody else will want to-morrow.

A New York firm that makes a specialty of electric installations uses the following catch-phrase in its advertisements: "Wire for us and we wiil wire for you."

The Comparative Cost of Steam Engines, Steam Turbines and Gas Engines for Works Driving

Some interesting data regarding the comparative cost of steam engines, steam turbines, and gas engines for generating electricity for light and power in a large plant are given by W. Schomburg in a recent number of the "Elektrotechnische Zeitschrift." At present a number of independent steam engines are used.

The day load, assuming that half the machinery is at work at one time at its ordinary load, is taken as 900 k.w., and the night load is about 250 k. w. No spare plant is to be installed, as a small electric plant with battery is available in case of breakdown; but future extensions are to be allowed for.

Coal, at $4.50 a ton, delivered, and having a thermal value of 12,500 B. T. U. per pound, is obtainable, and also coke at $5.75 a ton and of 11,700 B. T. U., while the cost of water is 5.4 cents a thousand gallons.

Assuming that the future extensions amount to half the present power, and that the future night load will not exceed one-third of the future day load, it will be advantageous to install two 440-k.w. machines rather than a single one of 900 k.w. A third similar 440-k. w. set can then be added later. Allowing for 300 working days in the year with 10-hour day shifts and 8-hour night shifts, the total units used will be as follows:—

Day shifts, 440 × 2 × 10 × 300 =	2,640,000 B. T. U.
Night shifts, 250 × 8 × 300 = ...	600,000 B. T. U.
Total annual units........	3,240,000 B. T. U.

The two generators will be approximately fully loaded during the day, while one alone will be run during the night, and will be only partly loaded.

RECIPROCATING STEAM ENGINES.

The engines are assumed to be of the three-crank, triple-expansion type, running at 140 revolutions per minute, and working condensing with superheated steam at 180 pounds per square inch, and a temperature of 250 degrees to 275 degrees C. The steam consumption at full load (allowing for the fact that the engines will not be running at quite full load constantly) is taken as 11½ pounds per I. H. P.-hour, which, with a generator efficiency of 92 per cent. and an engine efficiency of 88 per cent., making a combined efficiency of 81 per cent., gives 19¾ pounds per kilowatt-hour.

At night, working at about half load, the consumption will be about 22¼ pounds per kilowatt-hour. The total steam consumption at full load will thus be 17,700 pounds per hour, or, allowing for condensing machinery, feed pumps and pipe condensation, say, 21,000 pounds per hour. When the third machine is added, the consumption will rise to about 31,000 pounds per hour.

The condensers employed would be jet condensers, and the condensing water would be cooled in wooden cooling towers and used over and over again—the maximum quantity to be circulated (when the third generating set is in use) being about 60,000 gallons per hour. The condensing machinery would be driven by a 50-h.p. single-cylinder engine, and the two feed pumps would also be steam driven.

Three water-tube boilers, with a heating surface of 2700 square feet each, would be required, and the boiler house would have room for a fourth. Each boiler would be fitted with its own superheater for about 85 degrees C. of superheat, but no economizer need be provided, as the feed-water could be warmed by means of the exhaust steam from the feed pumps. A 24-inch exhaust steam main would be required. The details of the cost of this installation are as follows:—

CAPITAL EXPENDITURE.

(1) Two steam dynamos..........................	$54,000
(2) Three water-tube boilers, with super-heaters.....	15,000
(3) Condensing plant............................	11,500
(4) Feed pumps and oil separator..................	3,250
(5) Live and exhaust steam mains.................	1,875
(6) Feed-water and cooling water piping...........	1,375
(7) Overhead hand-driven crane for about 10 tons and 40-foot span................................	1,050
(8) Switchboard and connecting cables to dynamos.	1,750
(9) Coverings for pipe troughs....................	750
(10) Spare parts for engines, etc.................	1,500
(11) Coal trucks, ash trucks, rails, weighing machine, etc..	2,750
(12) Engine room, 33 feet high and 3800 square-feet area..	6,125
(13) 5200 square feet, boiler and pump house........	6,600
(14) Foundations for the steam dynamos, etc........	3,625
(15) One chimney shaft, 160 feet high and 8 feet internal diameter at the top....................	4,500
(16) Boiler brickwork............................	3,000
Total...	$118,650

The capital cost per k. w. installed is $\frac{23,730}{880}$ = $135, or, allowing for the future extensions, it is about $\frac{30,750}{1,320}$ = $117.50 per k.w.

ANNUAL RUNNING EXPENSES.

(1) Coal consumption:— 2,640,000 k.w.-hours, at $\frac{19¾}{7}$ pounds of coal per k.w.-hour, and 600,000 k.w.-hours, at $\frac{22¼}{}$ pounds of coal per k.w.-hour..........................	4,212 tons.
Heating-up (10 per cent.)................................	423 "
Feed pumps and condensing plant....................	425 "
	5,060 tons.
At $4.50 per ton................................	$22,530
(2) Lubrication and packing........................	$2,200
(3) Stoking, engine driving and supervision........	6,250
(4) Water purification............................	225
(5) Upkeep and repairs:	
3 per cent. on items (1) to (6) of capital cost....	2,610
2 per cent. on items (7) to (11) and item (16)....	215
1 per cent. on items (12) to (15).................	210
(6) Depreciation, 7 per cent., on items (1) to (19), (11) and (16)...	6,740
Depreciation, 3 per cent., on items (10) and (12) to (15)......................................	670
(7) Interest on capital at 4 per cent..............	4,745
Total	$46,635
Cost per k.w.-hour therefore = 1.38 cents.	

STEAM TURBINES.

Two units of 440 k.w. running at 2100 revolutions per minute (Parsons turbines) will be installed, and will require about two-thirds of the above engine room space. The steam consumption, allowing for the improved condensation required (about 90 per cent. vacuum) will be slightly higher than for the triple-expansion engines.

Each turbine will have its own condenser fitted close to it, and the condensing water cooler will have to deal with a maximum of about 115,000 gallons per hour. Upkeep and repairs will be about half as great as for the reciprocating engines. Lubrication will be greatly reduced and less attendance will be necessary, since in recent turbo-dynamos the commutation troubles have been successfully overcome. Comparatively light foundations will be required for the turbo-

dynamos, but the boiler house equipment will remain practically unaltered.

CAPITAL EXPENDITURE.

(1) Two turdo-dynamos	$35,000
(2) Three water-tube boilers, with super-heaters	15,000
(3) Condensing plant	14,000
(4) Hot well and feed pumps	1,700
(5) Live and exhaust-steam mains	1,375
(6) Feed-water and cooling-water piping	1,250
(7) Overhead hand-driven crane for about 7½ tons and 36-foot span	850
(8) Switchboard and connecting cables to dynamos	1,625
(9) Coverings for pipe troughs	875
(10) Spare parts for turbines, etc	750
(11) Coal trucks, ash trucks, rails, weighing machine, etc	2,750
(12) Engine room, 23 feet high and 2350 square feet area	3,875
(13) 2350 square feet boiler house	3,025
(14) Foundations for the turbo-dynamos, excavations for the condensers, etc	2,375
(15) Chimney shaft, 160 feet high and 8 feet internal diameter at the top	4,500
(16) Boiler brickwork	3,000
Total	$91,950
The capital cost per k.w. installed is thus	$104.50.

All the prices include freight and erection.

ANNUAL RUNNING EXPENSES.

(1) Coal consumption, including feed pumps, 10 per cent, for heating up and condensation loss = 5417 tons	$24,375
(2) Lubrication and cleaning material	400
(3) Stoking, engine driving and supervision	5,625
(4) Upkeep and repairs:	
1½ per cent. on item (1) of capital cost	525
3 per cent. on items (2) to (6)	1,460
2 per cent. on items (7) to (9), (11) and (16)	160
1 per cent. on items (12) to (15)	140
(5) Depreciation, 7 per cent. on items (1) to (9) and (11) and (16)	5,420
3 per cent. on items (12) to (15)	415
(6) Interest on capital at 4 per cent	3,680
Total	$42,220

Cost per k.w.-hour therefore = 1.25 cents.

GAS ENGINES.

Two gas engine dynamos for 440-k.w. each will be required, and these would preferably be of the 4-cycle, double-acting type with tandem arrangement of cylinders, though single cylinder engines could be used. The speed would be 130 revolutions per minute. Starting would be effected by compressed air provided by a small electric pump and air cylinder. The necessary cooling water would amount to about 9 gallons per horse-power-hour, so that cooling arrangements for dealing with a maximum of 20,000 gallons per hour (when three generators are in use) must be installed, and this amount of water must be cooled from about 40 degrees C. to 25 degrees or 28 degrees C.

Three power gas generators would be erected (one as a spare) with the necessary steam raising plant, purifiers, etc. Each generator should be amply large enough for 600 h.p., and with an efficiency of 75 to 80 per cent. each generator would require about 7,800 pounds of coke per day of 10 hours. Consumption tests on engines of this size were not available, but taking the guarantee figures of well-known makers, the consumption of coke should not exceed 1.65 pounds per kilowatt-hour at full load, or 2.45 pounds per kilowatt-hour at half load.

To allow for the losses in banking one gas generator during the night, an addition of 10 per cent. of the full load consumption must be made. The lubrication expenditure will be somewhat greater than for the triple expansion steam engines, whilst the attendance expenses will be less, owing to the absence of condensing plant. The foundations will, however, have to be more substantial.

CAPITAL EXPENDITURE.

(1) Two gas dynamos for 440 k. w. each	$56,250
(2) Three gas generators with purifiers, steamers, electric blowers, piping and valves	6,750
(3) Compressed air plant for starting	1,250
(4) Cooling water plant with electric centrifugal pump, iron cooling tower and piping	3,625
(5) Overhead hand-worked crane for 10 tons and 53-foot span	1,375
(6) Gas and air piping, exhaust chambers and valves for the engines	1,375
(7) Switchboard and cables from the dynamos	1,875
(8) Coverings for pipe troughs	1,450
(9) Spare parts for the engines and dynamos	2,250
(10) Weighing machine, rails, coke hoist, coke trucks, etc	4,000
(11) Engine room, 30 feet high, and 5400 sq. ft. area	8,750
(12) Gas generator room, 3600 square foot area	4,550
(13) Foundations and pipe troughing	5,500
Total	$98,300

The capital cost per k.w. installed is therefore $112.50.

ANNUAL RUNNING EXPENSE.

(1) 2,640,000 k.w.-hours, at 1.65 pounds of coke per k. w.-hour, and 600,000 k. w.-hours at 2.45 pounds per k.w.-hour + 10 per cent. loss in gas generator = 2810 tons of coke at $5.75 per ton	$16,160
(2) Lubrication and cleaning material	2,625
(3) Attendance and supervision	5,500
(4) Water for the purifiers (12,000,000 gallons per year at 5.4 cents per 1,000 gallons)	675
(5) Upkeep and repairs:	
3 per cent. on items (1) and (2) of capital expenditure	1,890
2 per cent. on items (3) to (8) and (10) expenditure	305
1 per cent. on items (11) to (13), expenditure	190
(6) Depreciation, 7 per cent. on items (1) to (8) and (10)	5,480
(7) Interest on capital expenditure at 4 per cent	3,970
Total	$373,355

The cost per k.w.-hour is therefore 1.1 cents.

The above figures show that in this case the steam turbines lead to the lowest capital cost, but that the gas engines give a lower annual cost. The writer points out, however, that no general rule can be laid down, since the price of fuel, the overloads to which the plant is subjected, the value of floor space and other similar variables enter into the question and make it necessary to consider each case in detail in the way outlined above.

OLD TIME TELEGRAPHERS' ASSOCIATION.

The twenty-sixth annual reunion of the Old Time Telegraphers' and Historical Association and the Society of the United States Military Corps was held at the Arlington Hotel, Washington, D.C., on October 9, 10 and 11. The Society was welcomed to the city by the President of the Board of Commissioners of the District of Columbia, Mr. H. B. F. Macfarland. The proceedings were largely of a social nature, concluding with a banquet which was attended by 300 persons. Mr. B.W. Trafford, general manager of the Chesapeake & Totomac Telephone Company, made one of the best addresses of the evening, briefly sketching the history of the telephone business, its close relation to the telegraph, and the wonderful extension of both enterprises.

Mr. L.B. McFarlane, of the Bell Telephone Company, Montreal, was the only Canadian present.

The importance of the independent telephone movement in Canada has been ealized by the Century Telephone Construction Company, of Buffalo, N. Y., who have taken possession of a commodious building on Adelaide street west, Toronto, where they will immediately commence to manufacture telephone equipment for every kind of service. The equipment manufactured here will be of the same superior quality as that turned out at their Buffalo factory.

TELEGRAPH and TELEPHONE

THE EVOLUTION OF THE TELEPHONE.*

By J. H. Winfield,
Manager Nova Scotia Telephone Company.

This paper might perhaps have been better called "The Development of the Telephone."

It is my purpose to sketch as briefly as possible the various changes and improvements in telephone apparatus which have made it possible for the telephone to become such a necessary factor in the social and business life of the world today. I shall also endeavor to convey to you an idea of the enormous development of the telephone business which has already taken place, particularly during the past few years, and the possibilities which still lie before us.

The telephone was first invented by Bell in 1874. Contrary to the idea of most persons today, it consisted solely of what is now known as the Receiver. It is possible to use the Receiver as a Transmitter. By first speaking into this instrument and then quickly placing it to the ear, it was found possible to carry on conversations over short distances when two instruments were connected by a pair of wires.

It was soon discovered that one wire could be eliminated and the earth used as a return as in Telegraphy. The limiting distance of speech was, however, very quickly reached owing to the extreme feebleness of the current generated when speaking into this Magnetic telephone.

The problem was then to discover some kind of an instrumen which would develop a heavier current so that it could be transmitted to greater distances. The problem was solved by the invention of what is known as the Carbon Transmitter. The most common form of this instrument in this country is what is known as the Blake Transmitter. This instrument, instead of generating the current in itself as the Magnetic telephone did, is operated by a cell of primary battery, the transmitter merely serving to vary the intensity of the current corresponding to the various sound waves falling upon its diaphragm. This, of course, was a long step in advance.

Up to this time the telephone had merely been considered as a toy, but now the idea of a central exchange to which a number of wires leading to various points were terminated by telephone instruments was introduced. In order to get a message through, however, you had to call central, who took the message and then repeated it to the person for whom it was intended. It was not long, however, before some ingenious person discovered that it was possible to connect two lines together and let the parties carry on their own conversation without the intervention of central.

This marks the beginning of our present central office switchboard system. The first boards were very crude affairs, arranged somewhat on the principle of the Western Union Peg Switch. Improvements, however, followed each other in quick succession, until what was called the Standard Switch was evolved. This consisted of annunciators arranged to expose a number when the subscriber rang his bell, and jacks, forming the terminals of the various lines, which were connected together when required by means of flexible cords with a plug on each end, each cord having a key by means of which the operator could listen in or send a ring either way.

In large offices a new difficulty soon arose. An operator could only reach about three feet on either side of her, and as the Standard Switchboard occupied about two feet in length for each one hundred subscribers, about five hundred lines seemed to be the limit of size of such a type of switch.

This difficulty was eliminated by providing trunk wires ending in jacks from each operator to every other operator. Calls for points beyond the reach of an operator were then switched on to one of these trunk lines leading to the section of the switchboard near which the jack of the desired line was placed, the switching being completed by the second operator with a second pair of cords.

The objection to this method of operating was that it required two operators to make a connection, and it was costly, cumbersome and expensive. In addition to this, there was considerable liability of error, owing to the number having to be transmitted through a second person.

Owing to the growth of business, this system was soon outgrown, as it was found that a thousand subscribers was all that could be properly handled even with the trunking system.

The next great step was the invention of the multiple switchboard, which took its name from the fact that each line was multiplied to a number of points on the board so that it was within the reach of every operator. The boards were divided into sections about six feet in length, each section accommodating three operators, who had a certain number of terminating lines and annunciators, depending on the traffic, the number being so arranged as to keep the operator fully employed, but not overloaded. Above the jacks of the terminating lines were placed the multiple jacks, there being one multiple jack in each section for every line coming into the exchange, and the sections being only six feet in length, it was quite possible then for each operator to reach every line.

Of course this system was very expensive, as on a board of say ten sections, it meant eleven jacks and a large amount of cabling, instead of only one jack. But the cost was easily offset by the immense superiority of the service.

This multiple arrangement necessitated the operator to ascertain whether any particular line was in use by another section so as to prevent another connection being made when the line was already in use.

This result was accomplished in several ways, one of which was to place a metal ring in front of each jack connecting all the rings of one set of jacks together. When a plug was placed in a jack, a battery current was thrown on to the ring, making all the rings on that particular line alive. Any operator having a call for that particular line would touch this ring with the tip of her plug, and if the line was in use, she would get the battery click in her receiver, otherwise there being no sound she would push the plug right home and call the party desired.

While these improvements were being made, other improvements were being worked out in the instruments and lines. The original grounded lines soon became noisy, owing to the introduction of trolley cars, etc., when it was found that a quiet line could be obtained by going back to the first principles, and using two wires for the circuit, cutting out the earth return. The Blake instrument was superseded by the long distance or solid back transmitter, which is a much more powerful instrument and can be used on very long distances, whereas the Blake was of very little use for a distance of over one hundred miles. The Blake transmitter also caused some trouble owing to getting out of adjustment, which is entirely obviated in the solid back.

The gradual growth of the exchanges soon began to load up the poles with wires much beyond their safety limit. Then it was necessary to use cables, which passed through varying improvements, until what is known as the Conference Specification was reached, which consists of pure copper wire insulated with wraps of dry paper, two wires of a pair being twisted together, the whole being enclosed in a lead sheath hermetically sealed in order to prevent the entrance of moisture.

The use of cables of course cleared the poles to a very large extent, but before long they became congested with cables and then it was necessary to go underground.

Many systems of underground construction have been successfully used, but the favorite seems to be a hollow tile laid in cement or concrete. This is practically indestructible.

These improvements bring us down to about 1900, when another great step in advance was made by the introduction of the Common Battery or Central Energy System. This takes its name from the fact that the energy for operating the transmitter is supplied from a storage battery at the Central office, instead of from a primary cell in each instrument. The same current is also used for signalling the operator, thus doing away with the small magnetic generator in the telephone instrument. Another great advantage of this system is that the battery supply is always constant, whereas with the primary cell it begins to deteriorate from the moment of its installation.

Another feature is that Central is called by merely taking the receiver off the hook, thus reducing the labor on the part of the subscriber and making the signal automatic. This is accomplished by placing a condenser in series with the ringer in the telephone, which is cut out when the switch hook goes up, permitting the battery current to flow over the line and operate a relay at the central office, which closes a local circuit, lighting a

*Paper read before the Maritime Electrical Association, Sydney.

small electric lamp on the switchboard, which is placed directly over a terminal or answering jack of the line. This lamp takes up very much less room than the old annunciator, and thus permits more multiple jacks to be placed within the reach of each operator, increasing the capacity of the switchboard.

On a large switchboard it has been possible to mount the multiple jacks on ⅜ inch centres, bringing from fifteen thousand to twenty thousand of them within the reach of each operator.

A very important feature of the Central Energy System is that the operator is enabled to determine the exact condition of the line at any time by observing the action of two small lamps placed in the cord circuit. The method of connection is as follows:

The subscriber taking down his receiver operates a relay in the central office, which lights a lamp in front of the operator.

The operator puts one of her plugs in the jack, which operates another relay, putting out the lamp. She then throws her switching key on to the cord circuit, ascertains from the subscriber the number of the party wanted, then takes the other plug belonging to the same pair of cords and taps the ring of the jack called for. If she gets a click, she reports "line busy." If no click is heard she pushes the plug right home and presses her ringing button. The connection is then completed. The lamp attached to the calling cord lights as soon as inserted in the jack, and remains in this condition until the subscriber answers, when the lamp is extinguished. As soon as the conversation is completed the subscriber hangs up his receiver and the lamp again lights, so that the operator is at all times in possession of complete information as to what is going on over the line, without the necessity of cutting in and asking unnecessary questions. It also enables disconnections to be made very rapidly, and has improved the efficiency of operating very materially.

The solid back transmitter only required a very slight modification to allow of its being used on the Central Energy system. The receiver remains today practically the same as when first invented. Of course improvements have been made in the mechanical features, but the electrical part remains absolutely the same with the exception that the original bar magnet has been replaced by one of the horse shoe type, giving a stronger magnetic field and a somewhat more sensitive instrument. By eliminating the magneto generator and battery, the subscriber's set has been made much smaller and neater.

The telephone has been one of the greatest features in the development of modern business conditions. It might be said that the modern "sky scraper" or office building would be hardly possible without the aid of a telephone. Some of the buildings contain from 500 offices up. Each of these offices has a telephone, some of them two or three. Each of these telephones is used on an average of 20 times per day at least, which would amount to a minimum of 10,000 calls to and from such a building per day. If these messages had to be handled by messenger boys as in the old days, assuming that each boy would carry 100 messages (certainly a large number), it would take 1,000 boys, which would crowd the streets and elevators, and absolutely prevent any other traffic from being carried on.

Yet the unobtrusive telephone on the wall or the desk does all this work quicker and more correctly, and at an infinitesimal part of the expense.

The telephone practically doubles the business man's day by saving his time and enabling him to accomplish more in a given time.

The growth of the number of telephones in use, especially in the last few years, is astounding Taking some of the Bell Telephone Companies in the United States. On January 1st, 1896, they had 280,000; 1897, 330,000; 1898, 390,000; 1899, 480,000; 1900, 610,000; 1901, 790,000; 1902, 1,000,000; 1903, 1,260,000; 1904, 1,500,000; 1905, 1,800,000, or 1 to every 42 inhabitants in the United States, a growth of nearly 600 per cent. in 10 years, and the end is not yet.

The Independent Companies have also a large number.

It is estimated that the development will not slow up until there is at least one telephone to every 15 inhabitants, or three times as many as at present. Some optimistic individuals go as far as to state that the development will be brought to one to every 5 inhabitants, but this is perhaps too much for us to look forward to, for a long time at least.

One of the most important advances in recent year is the Private Bench Exchange System.

This is a name given to a private telephone system connected with the main exchange by means of various trunk lines. It is used very successfully in factories, warehouses, departmental stores and all large concerns. The switchboard is installed with lines running to telephones in various parts of the building. As many telephone wires as are necessary run from the switchboard to the central office, so that in addition to the intercommunicating features of the warehouse system, it is possible to talk from any instrument to any part of the city. By employing an operator, blessed with a fair amount of brain matter, it is possible for her to sort out the calls coming in so as to put them on the proper department without any waste of time.

In one case that came under my notice very recently where a large wholesale firm had been persuaded, somewhat against their wish, to install a private branch exchange, a short time afterwards the manager stated that it was the best thing on earth, and whereas previously he had to answer the telephone 50 or 60 times a day, now he only answered it eight or ten times, just when he was actually required. Before he was simply doing the work of clerks and office boys, consequently the saving of his time alone was more than sufficient to pay all the cost of this system.

One possibility of development which has heretofore been neglected is that of placing what are termed "extension sets" which are subsidiary sets to the main instrument, enabling calls to be answered whenever an extension set is placed.

This has been used to some extent in offices where the main instrument would perhaps be placed in the outer office, an extension set being put on the manager's desk, enabling him to make or answer a call when required without leaving his desk.

But the field for this instrument is a very much larger one than this. Why not a telephone in every room in your house, so that when you are called you can answer without going up or down stairs? Of course most people will object to the expense, but through the introduction of a new form of instrument, it is found possible to install an extension set in a house and make a fair profit at as low a rate as 50 cents per month in some cases, and there is hardly any person who could afford a telephone who would not be willing to pay that much additional for at least one extra set, say to be placed upstairs, with the main set downstairs.

I have not touched on the long distance business, as it really requires a paper to itself. It is sufficient to say that the limiting distance of such was formerly 100 miles, and has been extended so that commerical business is now being done over circuits of 1,500 miles.

One feature not usually considered by persons in discussing this matter is that the telephone day is very short on the long distance lines, nine-tenths of the business being handled between 9.30 a.m. and 4.30 p.m. In long circuits running from east to west where the difference in time might be two or three hours, this day would be still further shortened, necessitaing very high rate in order to make such an investment pay.

This is one of the features that will be very much against telephone connection across the Atlantic, if we should ever reach the point where it could be carried out from an engineering standpoint. The difference in time being 4 hours, the length of the telephone day would not be more than 3 or 4 hours. Of course, the longer the circuit, the heavier the copper required to construct such circuit, in order to give efficient service, consequently theoretically all lines over 400 miles in length should charge a higher rate per mile than those under that figure.

The reason the limit is placed at 400 miles is that No. 12 Standard gauge copper is about the smallest wire that can be used from a mechanical point of view, and as this wire is good for circuits of 300 or 400 miles, a certain rate has been fixed for this. Over that distance heavier wire has to be used, and consequently a higher rate should be charged. The public on the other hand insist that the further they go, the cheaper they have to get it pro rata.

Composite telephony and telegraphy has been tried and is today being used on very many of the A. T. & T. Co.'s lines. This enables the company to earn a double revenue, one revenue for the telephone and the other for the telegraph, consequently they are enabled to give the telephone service at the 400 mile rate and still earn a dividend, owing to the extra receipts from the telegraph service.

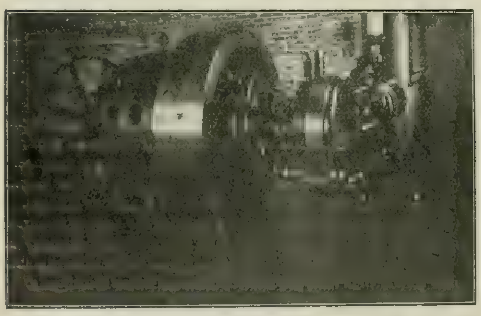
AN ELECTRIC PLANT IN NORTHERN MANITOBA.

Electrical work at Dauphin, Man., is in a very flourishing condition. This plant, which is owned by the town, was started on the 27th of January last. The power house is a one story and basement brick structure 45 x 70 feet over all, covered with iron roof. It is divided into two parts by a sold brick fire wall, one part being used for the boiler room and the other for dynamo room, with a small store room built in one corner. The boiler room is 40 x 45 feet, and contains two Robb-Armstrong boilers each of 100 horsepower.

Electric Power Station, Dauphin, Man.

The dynamo room contains a 100 horsepower Robb-Armstrong high speed engine, direct connected to a 65-kw revolving field 2100-volt, alternating current Westinghouse generator.

The switchboard has oil switches and all the latest appliances. There is also a series alternating arc circuit panel and regulator for the arc street lamps, of which the town has already got fifteen in use, all of Westinghouse make. The town has about four miles of pole line already up, and supplies current for about 2200 lights at the time of writing, the meter system being used. The demand for more electric lights is rapidly



Interior of Dauphin Electric Power Station.

increasing, not only for the many new buildings which are going up, but for many of the present buildings which have not been wired. The entire plant and wiring installation is in charge of Mr. Alf. C. Parkin, who was formerly in charge of the Gravenhurst, Ont., plant. Mr. W. A. Brinkman is the engineer at the plant. The town is now doing all the wiring and installation of lights, but at first most of the wiring throughout the town was done by Mr. R. S. Gordon, of the Jones & Moore Electric Company. An extra use to which the boilers at the plant are put is the supplying of heat for the municipal buildings and fire hall, the feed and return pipes extending under ground a distance of about 500 feeet from the boilers to the hall.

LOAD LEVELLING.

How to secure more day load is and always will be the great objective point of the aggressive manager who wishes to make the most of his new business department.

On-peak business is so vastly easier to get than off-peak business is, that unless care and forethought is shown by the management, the "peak" will be built up out of all porportion to the elevation of the "valley."

There must be some head work done by the manager.

There must be some training done with his solicitors, or he will find he is landing a lot of unprofitable business and very little of the profitable kind.

Power business is, of course, exceedingly desirable.

It is, as a rule, almost completely day load, and can be made entirely off-peak load with a little care and forethought.

But the rates must be made attractive.

Merely to show a man that by dispensing with belting and shafting, and putting in individual motors, he can save much of the power now being dissipated is not itself enough, for, as has been pointed out, what is to prevent that man from taking your tip and putting in his own dynamo, and thus effecting the saving without giving you any business.

What you must be ready and able to show him is this, that he can profitably buy your current at your price and save money over the price he would have to pay for running a private plant.

Then you have got him nailed up tight to something he can't get away from.

A 2, 3 or 4 cents per k.w.h. rate for large power business will talk louder and land more business than the cleverest of salesmen.

Many Central Stations have, as a last resort, built up their power load by buying up private plants, and as a matter of practice, this is something which does not want to be ignored.

Such a practice must, of a necessity, be limited by the capital of the plant and, naturally, it would be unwise for the company to go into such a business without having a pretty fair idea of an outlet for the engines thus secured.

But there is this about it.

The acquisition of a good, permanent load of power is so exceedingly desirable that a few dollars, or even a few hundred dollars lost within the course of a year or so on machinery bought up in this way can, it would seem, be afforded.—The Booster.

ENGINEERING SOCIETY OFFICERS.

Following are the officers for this year of the Engineering Society of the School of Practical Science, Toronto: President, K. A. MacKenzie; vise-president, D. J. McGugan; rec. secretary, E. M. Dann; treasurer, G. E. Quance; corresponding secretary, A. E. Jupp; editor, P. Gillespie, B. A. Sc.; librarian, E. G. Hewson; assistant librarian, S. A. Marshall; graduates' representative, A. Latornell; 4th year rep., D. G. Park; 3rd year rep., J. L. Rannie; 2nd year rep., A. W. J. Stewart.

CEMENT-COVERED WOODEN POLES.

Wooden poles entirely covered with layers of cement one and one-half to two inches thick have been tried in Switzerland with apparent good results. A brief account of some tests with these poles is given in the Indian Electrical, Mechanical and Textile News (Bombay), December. It is said that poles of this kind have been in use for three years, and it is hoped that they will prove to be as durable as well-kept iron poles, over which they have the advantage of cheapness. To prepare the pole it is first surrounded by wire netting supported from the pole by iron brackets. Then the whole of the pole is covered with cement to the thickness desired. These poles have been used in lengths of thirty-nine feet, forty-two and one-half feet and forty-six feet. Before adoption a number of tests were made with a thirty-nine-foot pole. These poles have a diameter of from seven to nine inches at the top and twelve and one-half inches at the base. The pole was embedded in the ground to a depth of five feet three inches, and was subjected to a pull thirty-three feet five inches above the ground. This pull was gradually increased until the pole broke, which happened when the strain was 2,370 pounds. Throughout the test the deflections were nearly proportional to the strain. When the pull was 1,860 pounds the deflection was two feet eleven inches.

STATIONARY ENGINEERS' LICENSE BILL.

Reprensentatives of the Ontario Association of Stationary Engineers conferred with Hon. Mr. Monteith recently in reference to the stationary engineers' bill passed at the last session of the Legislature, and which goes into effect in June next. The bill enacts that engineers in charge of engines of 50 horse power and over must have certificates of competency from a board to be appointed by the government. The association named now issues certificates to its members, and they desired to ascertain if there was any likelihood of conflict between theirs and the certificates to be issued by the board named. It was intimated that the association would have to adjust itself to the changes in the law, but as the new act may be altered in some respects at the next session of the Legislature the whole question will be fully discussed at a later period by the associations' representatives and Hon. Mr. Monteith.

A NEW LAMP GUARD.

The accompanying illustrations show a new lamp guard recently placed on the market by the Duncan Electrical Company of Montreal. The features of this guard are simplicity and strength, the rigid way in which it is fastened to the socket, and the ample space between the outside of the guard and the lamp.

The constuction of this guard is as follows: Ribs of hinges stamped from sheet steel and strung on spring steel wire rings, thereby insuring maximum strength and minimum obstruction to light. The steel latch is positive in action and attaches the guard to the socket. The whole is compact, self-contained and inseparable.

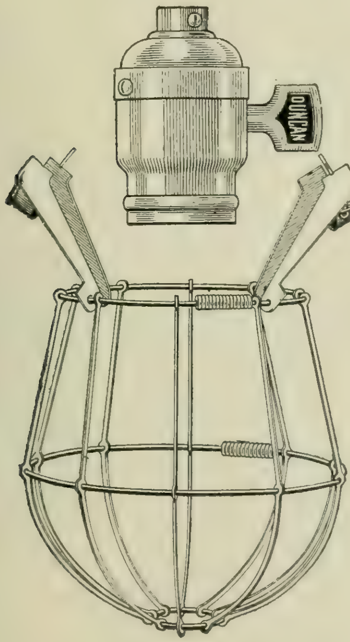


FIG. 1.—GUARD OPEN.

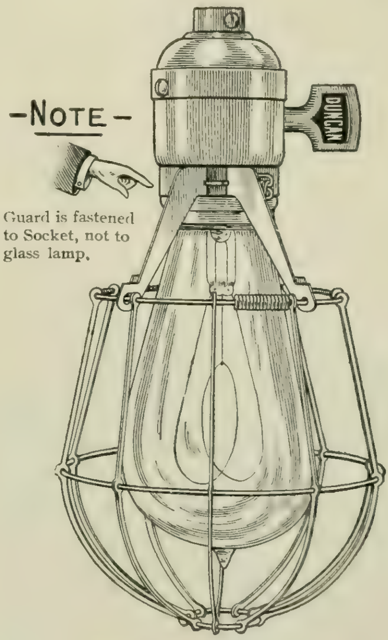


FIG. 2.—GUARD IN PLACE.

Fig. 1 shows the guard when open detached from the socket and placed over the lamp or bulb. It goes on with a spring, which is very secure, durable and simple.

Fig. 2 show the guard closed or attached to the socket; the connection is made away from the neck of the lamp, giving rigidity where it is needed. There is plenty of space between the lamp and the guard to prevent the bulb coming in contact with the guard.

The capital stock of the New Brunswick Telephone Comp[illegible] be increased from $[illegible] to $2,000,000.

The city council, of Windsor, Ont., have accepted a proposition by the Bell Telephone Company for a renewal of its franchise in Windsor for a term of five years, the company to place its wires in conduits on certain streets, remove the poles from Goyeau street, give the city six free telephones, and to pay $750 per year.

TRADE NOTES.

Babcock & Wilcox, Limited, announce the removal of their Toronto office to the Traders Bank Building.

The Sunbeam Incandescent Lamp Company of Canada have removed their general offices from the McKinnon Building to Nos. 1310-13 Traders Bank Building.

The Robb Engineering Company, Amhust, N.S., have received an order from Allis-Chalmers-Bullock for three 125 horse power engines for the C. P. R. Hotel, Vancouver, B. C.

Allis-Chalmers-Bullock, Limited, Montreal, recently sold to George H. Archibald, Kenora, Ont., one 100 h.p. induction motor, two 75 h.p., two 40 h.p. and two 7½ h.p. induction motors.

The Canadian Copper Company, of Copper Cliff, has bought from Allis-Chamlers-Bullock, Limited, Montreal, a pumping plant consisting of an 8-inch single stage turbine pump driven by a 70 h.p. induction motor.

The Calumet Mining and Milling Company, Calumet, Que., has increased its plant by a 12¼ by 18 "Ingersoll" air compressor driven by a 50 h.p. induction motor, both bcught from Allis-Chalmers-Bullock, Limited, Montreal.

Mr. William Perry, who for the past 30 years has been connected with R. H. Buchanan & Company, of Montreal, has severed his connection with that firm to join the John McDougall Caledonian Iron Works Company. Mr. Perry is the oldest pump expert in Canada, having been engaged in that class of work since 1851.

This year the Midland Electric Company, Montreal, have excelled themselves in their magnificent display of French bronzes, porcelains, and terra-cotta ware for electric lighting which they have imported from Europe for Christmas trade. We were afforded an opportunity to see the many charming and artistic pieces there displayed. We understand that the Midland Electric Company are the pioneers of this branch of the electrical business. They deserve great credit, and merit all the success which is coming to them for their enterprise. It would well repay our electrical freinds throughout the country to pay them a visit of inspection.

Among recent sales by the electrical department of Allis-Chalmers-Bullock, Limited, of Montreal, were a complete lighting plant, including a 110 k.w. generator, switchboard, transformers, lamps, line material, etc., to the town of High River Alta., a 50 k.w. generator, switchboard, etc., to the Canadia Pacific Railway Company for use at Toronto Junction, Ont., two 50 h.p. induction motors driving two 12½ x 18 "Ingersoll" air compressors to the City of Winnipeg, and a 32 h.p. induction motor with transformers to the St. George Electric Company, Beauce Co., Que.

SPARKS.

Mr. Cecil B. Smith, power expert for the City of Winnipeg, is having offices fitted up for him in the Carnegie Library Building on William avenue.

The introduction of the meter system in connection with the electric light plant at Huntsville, Ont., has resulted very satisfactorily, the revenue being considerably greater. This is a municipal plant.

Mr. D. H. Ross, Canadian Commercial Agent at Melbourne, Australia, states that a number of high grade Canadian motor cars were exhibited in September at the Royal Agricultural shows at Melbourne and Adelaide.

The Town Council of Welland, Ont., have given the Stark Electrical System, of Toronto, the contract for street lighting. The price is $40 per lamp per year for 2,000 c.p. lights, with a low guaranteed rate for residence lighting.

The municipal power and lighting plant at Bobcaygeon, Ont., was put into commercial operation on October 17th. Power is obtained from the Bobcaygeon river at Little Bob and converted into electrical energy by a 200 k. w., revolving field, 60 cycle, 3 phase, 2300 volt generator of Canadian General make. The streets are lighted by 22 6.6-ampere, series A. C. Adams Bagnal arc lamps and a number of 50 c. p. incandesent lamps. Mr. C. U. Peeling was the engineer in charge of the work.

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AN INTERESTING ELECTRIC PLANT AT WELLINGTON, ONTARIO

Wellington, an incorporated village in Prince Edward County, Ontario, is a summer resort with a winter population of 800. Situated on the Central Ontario Railway, 22 miles south of Trenton and 11 miles west of Picton, its southern boundary is the northern shore of West Lake and Lake Ontario, while the famous moving sand-hills are about two miles distant.

The industries of the village are three canning factories, farming, fancy seed peas and grist mill, and some minor undertakings. Lacking sufficient power for his other enterprises, Mr. Niles (the firm of W. P. Niles) applied for and received a charter for electric light and power supply; whereupon, owing to the publicity given to the generation of power by means of producer gas and also as a result of his own investigations, an order was placed by him for a producer plant. Finding it difficult, however, to personally undertake the details of electrical installation, Mr. J. Stanley Richmond, consulting engineer, was called in and, the producer plant not arriving, contracts were entered into for another producer plant and the other machinery and accessories required.

FIG. 1.—CONCRETE DAM AND SPILLWAY.

The location of the power-house is a water power site previously used for two or three other enterprises; and the wooden dam having been washed away, leaving a 50 foot gap in the earth embankment, a cement dam has been constructed, the upstream face of which is illustrated in Figure 1, and its concrete apron so formed that a pool of water below the spillway acts as a cushion for the falling waters.

Figure 2 is an illustration of the south end and east side of the power-house, which is 70 x 33 feet and, as will be noted, is well lighted. The concrete foundations of the building rest on rock, while the composition walls contain six inches of concrete, a two inch air space and four inches of brick made locally by Mr. Niles' men from fine sand mixed with one-tenth its volume of cement and air-dried. The inside of the building is divided into two rooms by a concrete wall, the smaller or producer room being 15 feet in height and having a smooth cement floor, while the larger or engine room is 12 feet high and has a double plank floor. The ceilings are of wood lined with metal ceiling painted white, and the roof is of corrugated iron. The insides of the walls are finished with cement plaster and buff kalsomining, while the inside woodwork of the windows is finished in light green with white sash work. All machinery foundations are of solid concrete set in and cemented to solid rock. A considerable amount of unpleasant work resulted during building owing to the surface water and water logged nature of the building site, but this was more than offset by the value of the location for the purpose it is now used and the improvement, generally, of an undesirable piece of property. The erection of the dam, too, provides the locality with a sheet of water suitable for a good open air skating rink, while the dredging which has been carried out on the west side of the building below the dam gives a systematic and straight water course for the waters of the creek, thereby preventing the rapid erosion of the west bank which formerly took place. The plant is designed for two 65 h. p. units, one of which is now installed.

FIG. 2.—BRICK AND CONCRETE POWER HOUSE.

The producer room, illustrated in Figure 3, correctly

speaking is the entrance to the building; and the producer unit which has been installed is located at the west end of the room. The auxiliary plant required for the operation of this gas generator consists of a "Jack of All Trades" 2 h. p. gasoline engine. This drives, as required, a blower, an air compressor and a small centrifugal pump. Overhead a cistern has been erected, divided into two compartments, one of which never receives any but cold water for supply

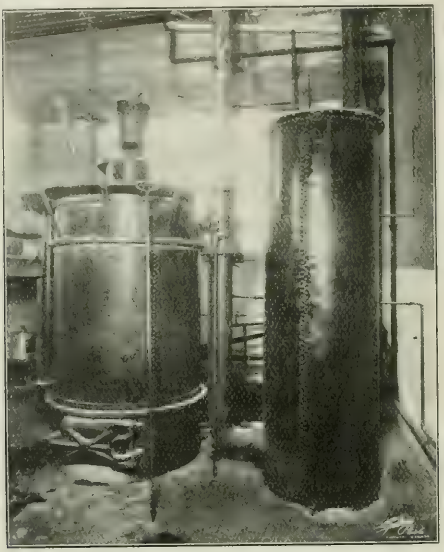


Fig. 3.—Suction Gas Producer.

to the evaporator on top of the generator and to the scrubber. The latter is filled with coke and serves to wash and cool the gases. The other compartment of the cistern supplies water for the cooling of the cylinder jackets of the engine, the warm overflow water from the engine being returned, when necessary, to it. A little over-flow water from the evaporator is allowed to run into the hearth below the furnace grate bars, which evaporates and serves to assist in the production of gas and to rot the clinker which collects at the base of the coal fire.

As will be understood, the gas from the generator is a very variable product; and to obtain it even approximately of a uniform composition necessitates systematic operation on the part of the attendant on watch. To deal with this phase of producer gas plant operation would require a lengthy article; suffice to say that the great secret is to keep a large hot free body of coal and a fire base as free as possible from clinker and that the scrubber should never be permitted to become warm for a greater distance above the floor than from one to two feet. The class of coal used is pea anthracite, which should be as free as possible from dust, moisture and shale.

A reference to illustration No. 4 will show that the engine is erected on a solid concrete foundation, which, contrary to the general practice, has its steps so extended that the attendant can comfortably stand upon them when oiling, starting, making adjustment and carrying out repairs.

The engine is provided with a circulating system of oil feeding, the oil after use being returned to the filter overhead. The current for the operation of the igniters is obtained by means of a battery (located on the wall) when starting and from a small apple dynamo (mounted on the engine bed) afterwards. To start the engine, compressed air is admitted to the third cylinder with the gas and air valves open and the first and second cylinders sucking the mixtures of air and gas. When fairly started, the third cylinder is cut off from compressed air and also sucks in the mixture. As an indication of the degree of suction at the gas valve and the gas generator, small pipes are run from these two points to two water guage glasses mounted on one of the adjoining walls, while a wrench board equipped with all the necessary wrenches and spare parts is also mounted convenient to the engine. The engine and subsidiary producer gas apparatus was all supplied by the Canadian Fairbanks Company.

The belts are double-ply best English oak-tanned leather, the one from the engine to the jackshaft being laced with steel wire lacing, and the one from the jackshaft to the electrical generator being endless. The jackshaft was built locally from scrap material, the "Jack of All Trades" engine being used for motive power. The pedestals are a continuation of the concrete foundation and have base plates on the top to which are bolted the solid pillow-blocks. The oiling of the bearings is also carried out by means of the circulating oil feed system. All the keyways are cut in this shaft for any future extensions, while the shaft also protrudes through both the east and west walls: on the west side, in case water power should be used as an auxiliary, and on the east side so that any ex-

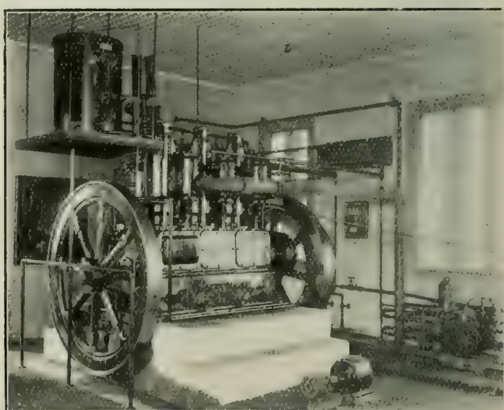


Fig. 4. -Gas Engine, Rear View.

tension of motive power outside of the present building can conveniently be taken care of.

The electrical generator, the motors used in the village, the special switchboard and the enclosed-type arc lamps were all contracted for by the Canadian Westinghouse Company. The electrical generator is of the type S, three-wire, 500-550 volt, 45 k.w., 4-pole, 900 r.p.m., D.C. class, and is the first machine of its class with the collector rings located within the spider casting on the commutator end. Fig. 5 shows the electrical end of the engine room, in which it will be noticed that the foundation is finished for the second

dynamo. The switchboard has two sets of busbars, most of the switches being double-throw, whereby any one or more of the generators can be used for either lighting or power circuits. The three-wire system, however, ends on the board, all the incandescent lighting circuits, eight in number, being two-wire, 250 volt ones.

Only 8 c.p., 125 volt incandescent lamps are used; and these are everywhere installed two in series, a method which reduces the capital outlay for copper to one-quarter of that necessary with 125 volt circuits, and which, though not used for a public supply before, has we understand been successfully adopted by Mr. Richmond in large buildings during the past ten years. The street lighting is carried out with the arc lamps connected up in series of 6 instead of the usual 5, whereby a 20 per cent. greater efficiency from the amount of power used is obtained; and, in order that perfect adjustment of the voltages of the circuits may be obtained as they vary due to the compounding of the machine, special rheostats have been ordered from the Westinghouse Company. By means of special apparatus, too, allowance has been made whereby 33 per cent. of the full load of the machine can be used for power purposes, while the remainder of its output can be simultaneously used for incandescent lighting.

The switchboard (which is fool-proof) was built by the contracting company and the pole and distribution system constructed by local employees from models built by the consulting engineer. The first two panels of the board, illustrated in Fig. 6, are generator ones, the third panel controls the power supply and wattmeters (two for incandescent lighting circuits, one for motor circuits and the other for street arc lighting), and the fourth panel controls the incandescent lighting circuits. Though not necessary technically, three small double-pole, double-throw balancing switches controlling a few lamps and one motor-pump are used on this last panel for economical reasons. As will be understood, therefore, the three-wire generator system has not been adopted for a three-wire supply (or, more correctly, distribution) but to lower the initial captical outlay and so that any one of the machines can be used for the operation of factory motors, street-railway motors, arc-lighting and incandescent lighting, whereby the system becomes a very flexible one and a correct lighting voltage can be kept up.

The local street mains are independent of each other, and independent feeders are run, respectively, to the centre of each from the power house. The compounding of the machines being 10 per cent., the sizes or the feeders are such that about 8½ per cent. drop will take place at full load on them before the local mains are reached, while the drops on the latter and inside wiring will amount to about 1½ per cent. under similar conditions.

The neutral (middle) wire of the switchboard is connected to ground, the patent rights for which were granted several years ago to Mr. Richmond by both the American and English Governments. The testing for ground is carried out by one of his special zero, above and before reading, duplex instruments which are manufactured by the Weston Electrical Instrument Company, while a fuse is arranged in the ground connection, the blowing out of which automatically rings an alarm bell as a warning to the attendant on watch.

The schedule of rates is an interesting one, power being supplied for motor driving at the flat rate of $20 per 10 hour h. p. per year. As for arc lighting, Mr. Niles has entered into a five year contract with the village council for 18 arc lamps at a charge of $520 per year, which is a trifle over $29 per lamp. For business purposes the charge is one-half cent per lamp per night, while residences pay a similar rate for those lamps which are fairly constantly used and only one-sixth of a cent per lamp per night for those which are only used at odd times. Churches and halls receive special rates according to circumstances.

A full motor load has already been obtained, while about 700 incandescent lights have been installed and requests made for about 200 more.

The capital cost entailed has been such that, with a full demand on the first unit, operating and fixed costs together with a small over-plus will be balanced by receipts; and, when the total capital cost is increased 33 per cent. by installing the second unit, the return over and above all costs to Mr. Niles ought to be very satisfactory.

To those who are acquainted with the lay-out of the Berlin, Ontario, municipal plant and its capital outlay to date, which plant, though its details are very different, has essentially similar machinery to the Wellington plant, it will be interesting to know that the

Fig. 5.—Dynamo End of Engine Room.

initial cost per h. p. of plant of the Wellington installation has only been to date about one-sixth that of the total capital outlay per h. p. of the plant which has been incurred on account of the Berlin installation up to the present time. With the second unit installed even a better showing will result, as the proportion will then be from one-eighth to one-ninth instead.

To Mr. Niles' progressive spirit is due every credit for undertaking and financing this enterprise, and it is hoped that the plant will result in as much benefit to

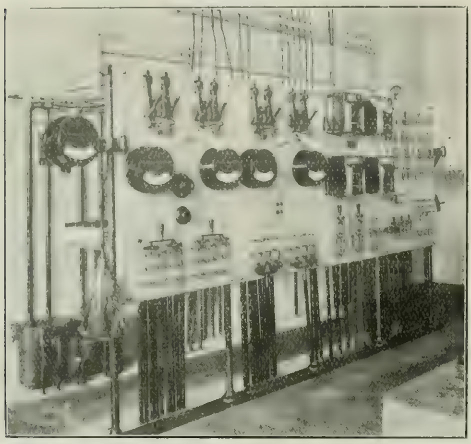


FIG. 6.—FRONT VIEW OF SWITCHBOARD.

him personally as to the inhabitants of the village, to whom, it goes without saying, the plant must have come as a great boon.

AN INTERESTING HYDRO-ELECTRIC PLANT.

A hydro-electric plant possessing some very interesting features is described by C. T. Rice in the Engineering and Mining Journal. The plant is that of the Eustis copper mine, in the Province of Quebec, Can.

The two alternators supplying current are run in parallel, and are mounted on the same shaft and driven by turbine water wheels. The water from the dam is carried by a flume to three pairs of 18 inch horizontal turbines mounted on one long shaft, on each end of which is rigidly coupled a revolving field alternator, one 150 k.w. in capacity and the other 200 k.w. These alternators generate a three-phase, 25 cycle, 2,200 volt current.

The effective water head on the turbines is 38 feet. Each pair of turbines is fitted with a separate gate-valve. The gate-valve of the centre pair is operated by a hand wheel, but the other two are operated by Woodward compensating governors.

In starting up, the hand-gate valve is opened, and when the capacity of this pair of wheels is reached the automatic governors are thrown into gear. In this way either one, two or three pairs of turbines are run according to the amount of power required. This effects a great saving of water, for each wheel is run more nearly at its full capacity.

The fields of both alternators are excited by a 13 k.w. generator, which is driven by a belt from a pulley on the turbine shaft. Both fields are in parallel. A Terrill automatic regulator, mounted on the switchboard and inserted in the fields of the alternators, keeps the current properly distributed between the two alternators, and thus the primary voltage is kept constant. A hand rheostat is also in each field circuit, so that the fields can be regulated by hand in case the Terrill regulator gets out of order. A reserve exciter, run by a separate water wheel, is used in case of accident to the other.

When only one alternator is generating a current and it is desired to use both, the field of the second alternator is thrown into circuit, and when the voltage is equal to that generated by the other machine the second machine is thrown in step. This type of design obviates the difficulty often attendant upon running alternators in parallel, for there is no trouble getting the two alternators in step.

The only difficulty in such a plant is connecting the two alternators in phase. This was done as follows: One alternator was coupled to the turbine shaft. Then the other was lined up with the turbine shaft and the couplings of each brought so near together that they almost touched. The second alternator was run as a synchronous motor, and when synchronism was established the faces of the couplings, which had been previously blackened by camphor smoke, were marked with a scratch awl drawn rapidly across the two coupling surfaces. Holes were then bored and the alternator rigidly fastened to the turbine shaft. The alternators were then always in phase.

The Temiskaming Telephone Company and the Haileybury & Cobalt Telephone System have amalgamated and are now under one management.

The farmers of Ladner, B. C., are combining with the farmers of Lulu Island for the purpose of establishing a tele-

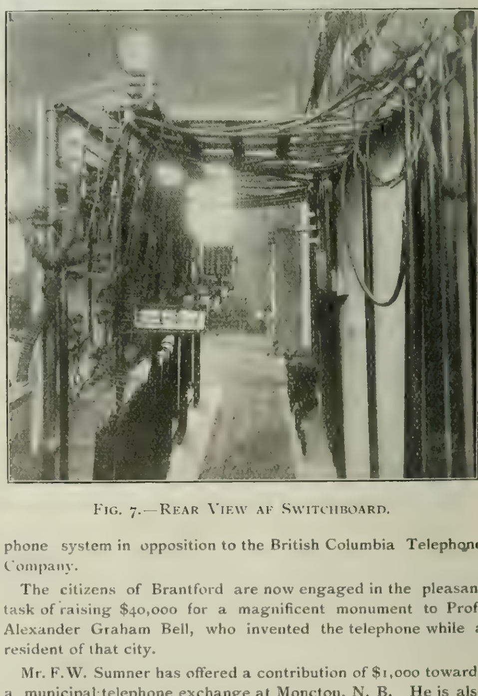


FIG. 7.—REAR VIEW AF SWITCHBOARD.

phone system in opposition to the British Columbia Telephone Company.

The citizens of Brantford are now engaged in the pleasant task of raising $40,000 for a magnificent monument to Prof. Alexander Graham Bell, who invented the telephone while a resident of that city.

Mr. F.W. Sumner has offered a contribution of $1,000 towards a municipal telephone exchange at Moncton, N. B. He is also willing to take $10,000 in a new provincial company which could not amalgamate with any other company without the authority of the Government.

ELECTRIC LIGHT INSPECTION.

In the annual report of the Inland Revenue Department, which reached us on the first of the month, we find the statistics concerning the inspection of electric light during the fiscal year ended June 30, 1906. The revenue derived from the inspection of electric light was as follows:

Fees for inspection of meters, &c.	$29,974 75
Registration of companies	5,125.00
	$35,099 75
The expenses of inspection (annual)	8,117.76
	$26,981 99
Expended on standard instruments, &c.	1,736 46
Leaving a net revenue of	$25,245.53

Since the year 1896-97 the two services of gas and electric light inspection, which are conducted largely by the same staff of officers, have reached that point at which they have ceased to be a burden upon the general taxpayer, as shown below:

GAS AND ELECTRIC LIGHT.

Years.	Revenue. $ cts.	Expenditure. $ cts.
*1899-1900	35,523.50	26,424 48
*1900-01	37,536.57	28,247 20
1901-02	45,663.05	33,328.48
1902-03	49,054.55	36,006.47
1903-04	50,218 75	33,426.15
1904-05	62,561.37	34,774.02
1905-06	76,539.00	38,917.48

*Exclusive of cost of standard instruments.

The following statement shows the number of electric light meters verified and rejected in each district:

Districts.	Number presented.	Verified as coming within the error tolerated by law.			Rejected.		
		Correct.	Fast.	Slow.	Unsound.	Fast.	Slow.
Belleville	1,008	534	289	185	....	..	1
Hamilton	1,252	300	356	595	.	7	1
London	1,772	1,310	221	233	.	2	1
Ottawa	2,424	580	207	1,633	1	11	50
Toronto	4,623	1,522	1,769	1,271	...	5	5
Montreal	5,219	4,161	1,021	23	4	1	1
Quebec	685	265	206	211	1	1	4
Sherbrooke	123	42	32	44	..	5	..
St. Hyacinthe	436	136	193	102	...	...	.
Three Rivers	138	64	34	40	...	2	2
St. John	788	391	174	[illegible]	....	3	3
Halifax	944	933	2		3	..	
Charlottetown	330	161	96	7	....	.	..
Winnipeg	3,099	2,597	154	348	....		
Edmonton	265	19	6	240	.	....	..
Vancouver	2,746	307	1,573	866	.		
Victoria	807	408	207	192			
Yukon	..	....	.	....			
	26,659	13,730	6,540	6,275	9	37	68

The number of companies registered under the Electric Light Inspection Act is 368, of which 274 are private plants and 94 municipal enterprises. These plants operated 1,828,507 incandescent lamps and 16,205 arc lamps. The Montreal Light, Heat and Power Company supply 3,069 arc lamps and 328,219 incandescents, and the Toronto Electric Light Company 1,722 arcs and 150,000 incandescents. The Ottawa Electric Company comes third, with 1,146 arcs and 137,393 incandescents.

The electric light inspectors of the different districts are: Belleville, Wm. Johnson; Hamilton, D. McPhie; London, A. F. Nash; Ottawa, H. G. Roche; Toronto, J. K. Johnstone; Montreal, A. Aubin; Quebec, N. LeVasseur; Sherbrooke, A. F. Simpson; St. Hyacinthe, J. E. Provost; Three Rivers, J. U. Dufresne; St. John, N.B., J. E. Wilson; Halifax, N. S., A. J. Ritchie; Charlottetown, P. E. I., J. H. Bell; Winnipeg, Man., R. Magness; Edmonton, Alberta, N. Harbottle; Vancouver, J. E. Miller; Victoria, R. Jones; Yukon, J. F. Macdonald.

CANADIAN ELECTRICAL EXHIBITION.

Letters patent were issued on November 23rd, 1906, incorporating the Canadian Electrical Exhibition Company, Limited, with a capital stock of $20,000, divided into 200 shares of $100 each, the incorporators being Messrs. William McLea Walbank, civil engineer; Raymond S. Kelsch, electrical engineer; Henry D. Bayne, manager; James A. Milne, manager, and John William Pilcher, manager, all of the City of Montreal.

It is the intention of this company to hold an electrical exhibition in Montreal in September next, and a similar exhibition annually thereafter. The company contemplate having an exhibition of everything used in connection with the electrical industry, and it is expected that it will be vastly superior to anything of the kind heretofore attempted in this country.

A meeting was held on December 5th for the purpose of completing the permanent organization, when the following gentlemen were elected as directors: W. McLea Walbank, R. S. Kelsch, J. A. Milne, H. D. Bayne, J. W. Pilcher. Immediately thereafter the directors elected W. McLea Walbank as President, R. S. Kelsch Vice-President, and J. W. Pilcher Secretary-Treasurer.

ELECTRICAL SPECIALTIES.

The Chase-Shawmut Company, of Newburyport, Masachusetts, U. S. A., have recently placed on the market their new line of 100-ampere 250-volt porcelian cutouts. This line includes both double and three pole main line cutouts and fills a long felt want among jobbers and contractors in general. Each cutout is enclosed in a corrugated paste-board sleeve and then packed in a pasteboard box, thus making it possible to ship the material without danger of breakage and at the same time making a very attractive shelf display. We understand that in a short time this company will also put on the market a line of single pole main line porcelain barrier bases in connection with their present line of slate bases. The capacities will be 30, 60 and 100 ampere, 250 volt, 30 and 60 ampere, 600 volt.

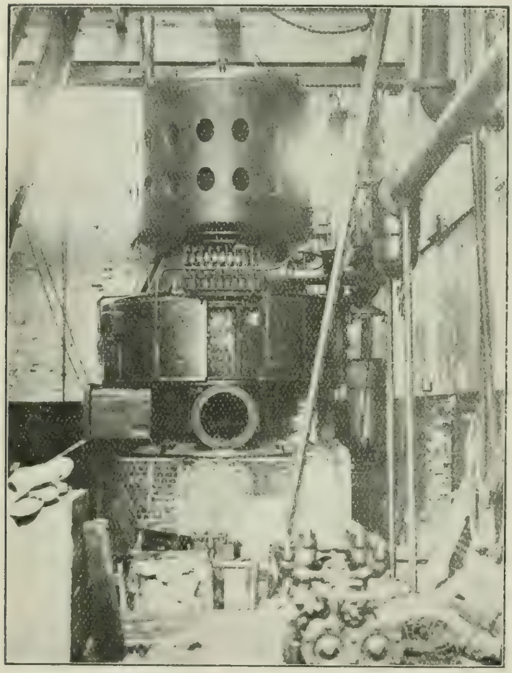
Another device which this company manufacture and which is proving to be very popular is their patented extended terminal type "A" fuse. This fuse in made in all sizes of the standard type "A". One terminal is extended so as to fit any of the standard makes of single pole type "A" bases. This extended terminal is scored and after being fitted to the proper base the projections may be easily taken off. The great advantage of this fuse is the reduction in stock that must be carried by the jobber. With this fuse the supply house does not have to wait before filling his order if he does not have a fuse of the same make as the base on which it is to go.

The R. E. T. Pringle Company, Limited, and John Forman, of Montreal, and Chas. Goodyear, of Winnipeg, Manitoba, are supply houses which handle the complete lines of the Chase-Shawmut Company.

For the year ending March 31st last the telephone subscribers in New Zealand increased by some 2000 over the number for the corresponding period last year. There are now 15,323 subscribers to the [illegible] the country, as compared with 13,423 connected with the Exchange in 1905.

2,000 K. W. Curtis Turbines at the Toronto Electric Light Company's Scott Street Station

It is probable that very few electrical men are aware of the great changes which have been taking place during the past year or more in the plants of the railway and lighting companies of Toronto. The early completion of these changes will find both companies with thoroughly modern plants in a position to handle the power which they will receive over the lines of the Toronto & Niagara Power Company. With the Toronto Electric Light Company, the equipment of an entirely new plant for the transforming and distribution of the power in a form suitable to the requirements of their customers has involved heavy expenditure,



2,000 K. W. Curtis Turbine in Course of Erection.

and has resulted in the installation of two complete plants, comprising transformers, switchboards, D. C. motor generator sets, frequency changing sets, rotary converters and auxiliary apparatus, at both the Scott and Terauley street stations.

On account of the great distance from the source of power and the importance of maintaining a continuous and satisfactory service, it was considered advisable to provide a steam reserve large enough to take care of any contingency. The requirements of such a plant called for large capacity for sudden and heavy overloads. It was essential that it should be capable of starting easily and quickly and be free from all complication in this respect. The question of floor space was an important one in this case, as the units were to be installed in one of the existing stations without interfering in any way with the operation of the present plant. It was desirable also that the units should be so designed as to float on the bus-bars as synchronous motors, thereby being useful in regulating the power factor of the system, at the same time ready to take up the load in case of trouble. The advantages of the Curtis turbine for such service were recognized by the management and orders were placed with the Canadian General Electric Company for two two-thousand kilowatt turbine driven alternators, operating at 750 r. p. m., to be installed in the Scott street station. As the first of these units is now in place and will be put into regular service within the next few weeks, the following short description may be of interest.

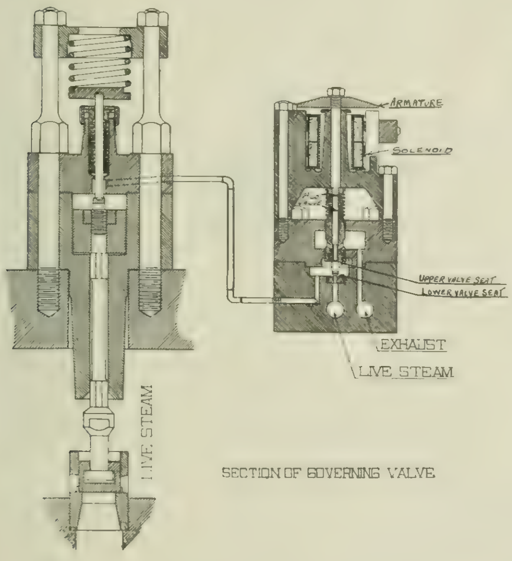
Following the design of all Curtis turbine-generator sets of large capacity, these machines are of vertical type, having the generator supported on a sub-base over the turbine. The extreme height from the turbine base to the top of the governor dome surmounting the generator is 20 feet 6 3/8 inches. The maximum diameter is 11 feet 2 inches and the weight of the complete set 190,000 lbs. It may be noted that the first set has been put in position ready for steam in less than three weeks, all handling of parts being accomplished without the aid of a travelling crane.

The most radical departure from conservative lines in these turbines is the vertical form, involving the use of a step-bearing lubricated under considerable pressure. This feature was the cause of considerable skepticism when first introduced; but the fact that there are now in satisfactory operation some three hundred units of this type, all over 500 k. w. and aggregating 240,000 k. w. capacity, is evidence that such fears were groundless. It may be mentioned that in the report on Steam Turbines of the National Electric Light Association for 1905, the statement is made that in fifty-seven plants examined, the committee had been unable to find a single case in which the step-bearing had given any serious trouble. The compactness and symmetrical form of the vertical machine eliminates trouble due to unequal expansions. Both the revolving element and the casings expand from the base upward; the latter being designed without projections or cored exhaust passages, are free from distortion.

The step-bearing consists of two heavy, circular cast iron plates, one of which is keyed to the foot of the shaft. A shallow recess is turned in the faces of these plates, into which the lubricant is forced, under pressure, whence it passes to the outer edges in a thin film. A casing projecting into the base of the machine contains the step-bearing plates and also carries the lower guide sleeve or steady bearing. Water, under a pressure of about 450 lbs., supplied from a pair of 7½" x 2" x 6" duplex, high pressure steam pumps, is used to float the revolving parts. After passing through the step-bearing, this water passes up through the guide sleeve into the base of the turbine, whence it is carried to the condenser with steam. Either of the high pressure pumps referred to is capable of supplying sufficient water for the bearings of both machines, the intention being to have the second pump in readiness in case of emergency.

The functioning of the steam is carried through four stages separated by heavy diaphragms. Steam enters each stage through expanding nozzles, the number and cross-sectional area of the nozzle openings increasing as the lower pressure stages are reached, corresponding to the density of the steam at that point. Interstage leakage about the shaft is prevented by grooved, metal packing rings. A packing consisting of carbon rings and sealed with steam prevents leakage in the shaft opening at the top of the turbine.

Each stage contains a cast steel bracket wheel keyed to the shaft, carrying two rings of buckets. Between these revolving buckets is a single row of stationary buckets attached to the casing. All buckets are of cast bronze finished to template. The expansion of the steam takes place in the nozzles of each stage, the buckets serving to absorb the kinetic energy of the resulting steam jet. The minimum axial clearance between the stationary and revolving parts is 1″ and the design of the bucket segments is such that should



SECTION OF GOVERNING VALVE

"rubbing" occur, it takes place between projecting shoulders, resulting in no injury to the buckets.

Two banks of governing valves control the admission of steam to the turbine. Each group consists of ten valves, which supply steam to as many nozzle openings These main valves are simply a form of poppet valve actuated by unbalanced steam pressure. The dia meter of the piston on the upper end of the valve is greater than that of the valve seat, so that (supposing the valve to be closed) if steam is exhausted from the top of the piston, the piston will rise due to the unbalanced pressure, thereby raising the valve from the seat. Each main valve is provided with a solenoid-operated, double seated pilot valve. When the solenoid is energized, drawing down its armature, it breaks the pilot valve from its upper seat and closes the port to live steam. This allows the steam on top of the piston to exhaust to atmosphere or vacuum, and raises the main valve. The reverse operation takes place when the solenoid armature is released. The pilot valve is thrown back against its upper seat, closing the exhaust and opening the upper side of the main piston to live steam. The main valve is then closed by the pressure of the heavy spring above.

The speed regulating governor, fitted to the top of the generator shaft, by its motion, actuates the fingers of a small controller, which forms part of the circuits to the individual solenoids, thus automatically controlling the supply of steam. Speed regulation from no load to full load is guaranteed to be within two per cent., with maximum momentary variation of less than four per cent. This valve mechanism was proved satisfactory under the most severe conditions with steam pressures exceeding 200 lbs. and temperatures of 650 to 700 degrees F.

As the governing is all accomplished at admission to the first stage, the pressure of steam in the lower stage varies with the load. Under overload conditions, however, two by-pass valves are provided, which automatically open at predetermined pressures to admit steam which has passed through the first stage to additional sets of second stage nozzles. The turbine thus has a capacity of about one hundred per cent. overload with practically no increase in the rate of steam consumption over full load conditions. It will carry full load (2000 K. W.) when operating non-condensing.

In case of failure of the governing mechanism, two independent centrifugal devices are provided which act at a speed ten per cent. in excess of normal to close a valve in the main steam pipe, at the same time opening a valve in the lower part of the machine to break the vacuum.

Oil for upper guide bearings is obtained from a tank supported on brackets on the generator top shield and piped directly to the bearings, through sight feed cups. A gravity system fed by a pair of small pumps furnishes a constant supply of oil to the lubricating tanks on both machines.

The generators are three-phase, four-pole, 25 cycle, revolving field machines, operating at 750 r. p. m. They are wound for 12,000 volts, this being the potential at which current is received from the terminal station of the Toronto & Niagara Power Company. The revolving field is rigidly coupled to turbine shaft. It is built up entirely of laminated steel plate and wound with specially formed, edgewise copper coils, firmly braced against lateral movement by inter-polar brackets. The stationary armature is of unusually strong construction, designed for the heavy service to which it will be subjected. The temperature guarantees are very conservative, viz., after 24 hours full load, a rise of not more than 40 degrees C., 50 per cent. overload for two hours with a rise of not more than 55 degrees C. The machine will stand momentary overloads of one hundred per cent. without injury.

The guaranteed economy of these sets with 150 lbs. dry steam at the throttle and two inches back pressure is 20.5 lbs. steam per k. w. hour at full load and 22 lbs. per k. w. hour at half load. From the results obtained upon similar units installed elsewhere, it is expected that these guarantees will be easily met and probably improved upon.

It is well known that the steam turbine is peculiarly adapted for economical operation with a high vacuum, and for this reason it is customary to install surface condensers in connection therewith. In this case, however, it was felt that with the intermittent character of the load, the additional cost of surface condensers would probably out-weigh the gain due to re-

duce steam consumption. Besides this, the simplicity of operation and low maintenance charges of the jet condenser were important considerations. Each turbine will be provided with a specially designed jet condenser capable of maintaining a vacuum of 26 inches with injection water at 60 degrees F. the turbine carrying an overload of 25 per cent. equivalent to about 52,000 lbs. steam per hour.

Each condensing outfit includes a condensing chamber, about five feet in diameter and ten feet high, a two stage turbine pump operating at 300 r. p. m. and driven by a 10″ x 10″ vertical engine and a twin coupled steam-driven, marine type Edwards air pump, 8″ x 20″ x 12″, operating at 125 r. p. m. The turbine pump has a capacity of 3000 to 4000 gallons per minute and is connected into the base of the condensing chamber to carry off the bulk of the water. The Edwards air pump is employed to remove the entrained air and vapors from the upper part of the chamber, thus maintaining a high degree of vacuum. These condensers were designed and built by the Canada Foundry Company, Toronto.

In conclusion it may be stated that all work on turbines and generators was carried out in the shops of the Canadian General Electric Company, Peterboro. This company also furnished all switchboards, rotary converters, motor generator sets, etc., for the new plants of the Toronto Electric Light Company.

AN UNUSUAL TRANSMISSION LINE SUPPORT.

Difficult conditions for a high-tension transmission line were encountered along the banks of Lake Luzerne,

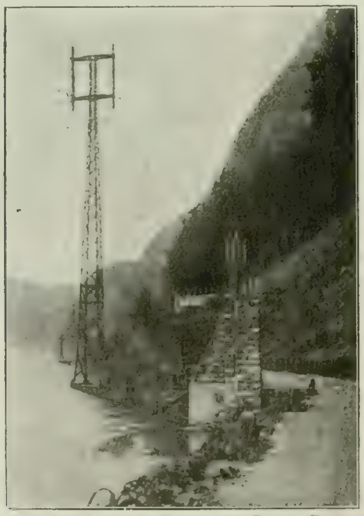


Fig. 1. View of Luzerne-Engelberg Power Transmission Line along the Lopper Road, Shore of Lake Luzerne.

in Switzerland, where a triple 25,000-volt transmission line extending from Obermatt 16.7 miles to Luzerne, runs along a steep, rocky mountainside. The photograph (Fig. 1) herewith shows the means resorted to. The road seen in the illustration extends along the foot of a wooded precipice, on the immediate edge of the lake. The outer edge of the road is occupied by a telephone and telegraph line of some 20 wires, and it was necessary to keep the transmission line well away from these wires. At the same time, the bottom of the lake falls away so steeply that it is impracticable to set poles or towers any distance from the shore. The danger of occasional falls of trees or rock from the mountainside, again, made it advisable to keep as far from the mountainside as possible. The construction which apears in the photograph, comprising cantilever supports for the transmission-line towers, which carry the line some 20 ft. out from the bank, was devised as a solution of these difficultes.

Fig. 2 shows one such cantilever and tower, as viewed in the direction of the line. The structural

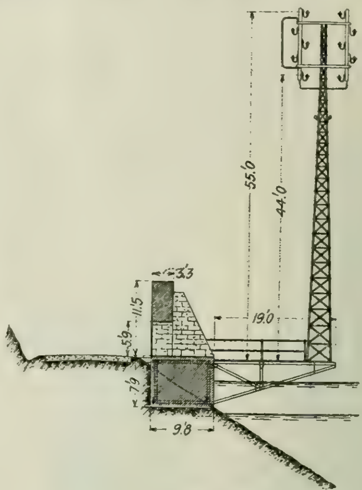


Fig. 2.—Sketch of Transmission-Line Tower on Cantilever Support.

features will be self-explanatory. The masonry foundation and anchorage is topped with a wall on the land side to protect the pole against falls of debris from the hillside. In order to reduce the number of these special towers the normal span length of 200 ft. was increased to twice this amount on the section concerned.

The pole-top used on this line is also of interest. Two transverse steel channels riveted to the tower carry oak uprights at their outer ends. The insulator supports, of galvanized iron, are fixed to the uprights in staggered arrangement, with a spacing of 39 ins. between wires. On curves, iron guards as shown in the drawing surround the outer and bottom rows of wires. Further data on the line and power plant (Luzerne-Engelberg power plant) may be found in the "Schweizerische Bauzeitung," from which the above is taken.

The Peterboro Light & Power Company have offered to sell their distributing plant to the city at cost. If the offer is accepted, they agree to furnish the municipality with power at $15 per horse power sufficient to provide for the present lighting business and extensions for three years, also 500 additional horse power for manufacturing purposes at the same price.

The preliminary work in connection with the proposed power development at Point du Bois for the city of Winnipeg is now well under way. Mr. C. B. Smith, who has entire charge of the work, has appointed the following staff: R. D. Johnston, chief engineer; E. B. Merrill, chief electrical designer; Norman Gibson, assistant hydraulic designer; P. H. Mitchell, ele trical designer; C. Holden, electrical engineer; Edgar Guy, general designer.

Polyphase Systems of Generation, Transmission and Distribution*

By M. A. Sammett, A.M.Can.Soc.C.E.

Every electrical development possesses some typical peculiarities which should be the determining factors in the selection of the frequency of the system as a whole, as well as the selection of the generating and distributing systems as to phases, that is, whether it should be two or three phase.

These are the problems with which we will concern ourselves in the discussion of polyphase systems, with a transmission line of 100 miles or less and pressures up to and including 50,000 volts at the receiving end. While the paper is limited to these two considerations alone, the ground to be covered is rather wide, requiring therefore a concise treatment of various characteristics.

It is but natural that a system with a railway load principally will call for a layout which will not answer best the needs of a lighting and power company, and a development where the power is to be used for some particular application may again call for a layout differing from the two mentioned above.

Every system is, therefore, influenced in its design by the nature of the load, and while a purely railway system will prove most economical and satisfactory with a given frequency, and two phase synchronous converters at the substations, lighting and power companies will require a different frequency and strictly three phase system. To compare the advantages of the three phase as against the two phase systems and of the two principal frequencies is the aim of this paper.

We shall take up first the question of phases.

Whatever the generation and distribution, the transmission of power is always accomplished by three phase. This arrangement allows of most economical transmission of power with a given drop in the line. While the transmission of power is invariably accomplished by three phase, the generation and distribution is often by two phase.

Modern engineering practice shows, however, the abandonment of the two phase generator in connection with hydro-electric power houses, where power is to be transmitted and consequently transformed from two to three phase. The common belief of the simplicity of the two phase generator and switchboard is more imaginary than real and came about as a result of clinging to the more familiar two phase generator which at the time just preceding the era of generation for transmission purposes was the standard apparatus, answering best the needs of small central stations with a lighting load, the amount of power forming a very small proportion of the total load.

It must be admitted that a two phase system for distribution purposes is somewhat simpler to operate than a three phase system. The two phases may be controlled independently for single phase lighting circuits without any appreciable ffect of one phase on the other.

In the case of motor connections on two phase circuits, all that is necessary is to connect the two transformers with the primary coils to the line, and the secondary coils to the motor. No special attention is required as to polarities of transformers. The impedance of transformers need not be the same for proper division of load, as is essential in connections of three phase installations.

It was this at first sight simplicity which appealed to the engineer in laying out the first hydo-electric power houses, and even at the present time some engineers persist in their preference for the two phase generators, and at the receiving end go through another transformation from three to two phase in order to supply two phase current at the distributing end.

Let us take up the generating plant first and see which of the two systems, three or two phase, is more efficient as well as more economical.

Power House: It is pretty well known that for a given capacity, speed and voltage, at a given frequency, the three phase generator will prove the more efficient machine. Manufacturers standardizing apparatus use the same frames and punchings for the two different types. This enables the manufacturer to turn out a better three phase generator as to efficiency and heating, retaining the same core loss. Should he, however, select to keep the same density in the copper of the three phase as in the two phase machine, he will be in a position to reduce the magnetic flux by virtue of the larger number of turns that can be accommodated in the same slots, and thus considerably reduce the core loss. Inasmuch as the core loss in machines of large capacity is considerably greater than the copper loss, this will result in a material increase in the efficiency of the generator.

Switchboard: Taking up next the switchboard, we will find that the only advantage the two phase board has in comparison with the three phase, is the saving of one ammeter. It is standard practice to use an ammeter in each leg, therefore the three phase boards will require three ammeters. It is also maintained that the figuring of the K.V.A. load from the instruments is a more difficult matter with a three phase than with a two phase installation, as no factor is used in the latter case in computing the apparent K.W. of the station's output. The above objections have very little weight when compared with the advantages of a three phase board.

All busbars, oil switch contacts and switch compartments, all cables from generators to switchboard and from the board to the transformers are reduced in the ratio of 4 : 3, and while 15.6% larger cross-section of copper is required in the instance of the three phase installation, maintaining the same current density, the 25% saving in the number of individual parts necessary for the installation will be in favor of the three phase board.

Transformers: The use of two transformers for a given load allows a greater individual transformer capacity, and therefore a more efficient transformer. This would have been a decided advantage, favoring the two phase system, were it not for the fact that the transmission of power is to be by the three phase. To accomplish this phase transformation by the well-known Scott connections, unless all transformers are provided with a heavier high tension winding, the

* Paper read before the Electrical Section of the Canadian Society of Civil Engineers, November 15th, 1906.

transformer capacity would of necessity be reduced, due to a higher current in the three phase winding, namely, that of 115.6% of the normal current. Should, however, the transformers be designed with provision made for this higher current, it would necessitate larger transformers, or in other words, a more expensive installation. Beside this increased transformer capacity, another disadvantage must be added, that of a possible resonance with T connected transformers for two-phase-three-phase transformers. Whenever one of the phases is open, due to a failure of making proper contact of various switches or any of the auxiliary connections, the high reactance of the high voltage transformer will get in series with the capacity of the transmission line and a resonance is likely to take place with the consequent disastrous results.

We have shown the advantages of using a three phase generator. This advantage is further augmented by the possibility of using transformer connections with which the danger of resonance is eliminated. Of the transformer connections in vogue, there are two which are free from the danger of resonance, namely, △ to △ for step-up and △ to △ for step-down, or △ to Y and Y to △. Neither of these two has the objectionable characteristics of resonance and while the △ to Y and Y to △ is selected for transmissions where highest voltages are made use of, it is the △ to △ and △ to △ which gives the most reliable service. With the latter style of connections, should one of the transformers fail, as soon as this transformer is cut out the service may be restored. This latter connection, namely, △ to △ and △ to △, which insures both continuity of service and freedom from resonance, is introduced now on one of the 60,000 volt transmission lines and is destined to become the standard, inasmuch as high tension transformers of 60,000 volts as well as the insulators, especially if the latter are carefully selected and tested, have the requisite factor of safety, making the resort to the Y connections, at a sacrifice of continuity of service, unnecessary.

Distributing System: The considerations which held true in the discussion of the transmission line will also hold true in the distributing system. The three phase delta connections should be made use of, since on motor service a complete shut-down due to a failure of one transformer must be carefully guarded against. Again, the three wire three phase distribution will result in a saving of 25% of copper and insulators. It will reduce the maintenance expense by the same percentage.

The advantages thus enumerated show clearly the desirability of three phase distribution from the purely commercial standpoint and still more so from the point of view of reliability and permanency of supply. Some engineers object to the three phase distribution on the ground of the difficulty of balancing loads. This objection must not be given much importance. With the mixed load of lighting and power, the power load has an equalizing tendency on the balancing of the system and with some attention given to the proper division of the connected lighting load, no difficulty will be encountered.

The station records should be carefully watched, and occasional re-adjustment of the load, based on station records as well as tests of individual installations, will permit of as careful a balance as one may desire.

Record of Amperes Per Phase on a Three-Phase Circuit.

Time.	A	B	C
12 Midnight	20	25	25
1 A. M.	25	25	25
2 "	5	5	5
3 "	10	10	18
4 "	5	10	18
5 "	10	10	10
6 "	10	10	10
7 "	25	25	25
8 "	95	93	95
9 "	92	90	90
10 "	93	93	93
11 "	97	97	97
12 Noon	87	87	87
1 P. M.	75	70	75
2 "	90	87	90
3 "	92	92	92
4 "	75	75	75
5 "	105	100	95
6 "	125	130	120
7 "	40	40	35
8 "	55	55	50
9 "	50	45	45
10 "	40	40	40
11 "	40	40	40
12 "	12	12	15

It is imperative for the success of any central station to build up a good load and to broaden out the peak. This means to secure a considerable motor load. Let us see, therefore, what are the relative advantages comparing two and three phase motors. The induction motor is the one upon which to base our comparison, as it is the motor in general use.

While the characteristic which affects the central station is that of power factor, the power being sold by the energy input, we must not confine our comparison to this point alone, but having in mind the good derived by the motor user in securing a better motor, we will discuss the relative merit of the two phase and three phase motors in a general way.

The comparison can best be made from a summary of a convention paper by Mr. Bradley McCormick read recently before the American Institute of Electrical Engineers. Given two similar frames without windings, how shall the two phase and three phase windings differ in order to secure proper operation? What will be the comparative losses if the two machines are given the same rating?

1. A two phase machine should have 22% more conductors per slot than the corresponding three phase Y connected machine, designed for the same voltage and flux per pole.

2. The magnetizing current is the same in both the two and three phase machines when expressed in percentage of the current, which corresponds to the full load output.

3. The copper loss of the two phase machine is 12% higher than that of the three phase.

4. The leakage factor of the two phase machine averages 25% greater than that of a three phase machine, therefore the power factor is lower.

Actual results show from 1 to 3% lower power factors.

These considerations show that the two phase machine will have a higher temperature rise as a result of a higher copper loss. For the same reason the efficiency of the two phase motor will be lower. The slip of the two phase machine will also be greater. Tests and theoretical calculations show 20% greater slip.

Thus we see that the two phase induction motor is

a poorer motor for the central station company, due to a poorer power factor. It is also less advantageous to the power user, as a smaller efficiency means a larger motor input for a given output. The higher temperature rise will result in a shorter life and larger slip and will mean a greater fluctuation between synchronous, partial and full load speeds.

While the three phase service should be made standard, two phase motors may be used by the aid of three-phase-two-phase transformers. This, however, should be discouraged, as such transformers require special taps, which make them more expensive, especially so when core type transformers are used. It also means the carrying of a stock of these special transformers as spare units. The above consideration as well as the larger capacity of transformers required in cases of phase transformation makes the two phase motor objectionable and its use should be discouraged.

This will conclude the remarks as to the advantage of a three phase as compared with a two phase system.

We will take up now the discussion under the heading of frequency.

FREQUENCY: The frequencies most widely used on this continent are those of 60 and 25 cycles. While other frequencies are made use of these are the predominating ones. Let us, therefore, analyze them with a view of determining their adaptability for such developments as are under discussion in our paper.

We shall make our analysis not from the transmission point of view alone, but analyze the generating and distributing systems as well.

As far as the transmission line is concerned, the lower the frequency, the less the induction drop, the smaller the charging current and the better the regulation. It is a foregone conclusion that as a purely transmission problem, we will have to adopt the 25 cycle frequency. Our problem, however, is more complicated. The transmission line is only a chain in the link, and important as it is, it should not overrule the advantages of a higher frequency as applied to the distributing end of the system. In our composite problem the various advantages and disadvantages should be carefully weighed and the selection made on the merits of advantages of the entire system taken in its totality.

POWER HOUSE: The table of speeds of generators at 60 and 25 cycles shows a wider range of speeds, hence a greater flexibility when laying out a 60 cycle hydro-electric power house.

R.P.M. 25 cycles 300 250 214 187 166 150.

R.P.M. 60 cycles 327-300-277 256-240-225 212-200 190-180 172-164 156-150.

The speeds of turbine-generator units are limited by the number of wheels, type, head and output. Therefore a wider range of speeds permissible with a 60 cycle system will enable the selection of the most efficient generator-wheel combination. Inasmuch as increased peripheral velocities will result in a decrease in active material, the selection of higher speeds will enable us to choose cheaper hydro-electric sets. The above conclusions hold true except when higher speeds call for special construction, which will rapidly increase the cost.

SWITCHBOARD: The switchboard under the two frequencies is unaffected. All meters and potential and current transformers are designed for satisfactory operation on frequencies from 25 to 125 cycles. In our comparisoin of 60 and 25 cycles it may be said that while the temperatures of the switchboard shunt transformers will be less at 60 cycles, the series transformers will operate at higher temperatures, due to a higher iron loss. The temperatures, however, will be well within the margin of permissible safe operation.

TRANSFORMERS: Transformers built for 25 cycles are a much more expensive piece of apparatus as well as less efficient than when built for 60 cycles. Considering that there is with a generation, transmission and distrubution of power a total transformer capacity equivalent to from 3 to 4 times the capacity of the generating apparatus, one will readily see the advantage of a higher frequency. This, however, must not be done at a sacrifice of other considerations, such as excessive charging current in transmission or extremely poor regulation. We shall come to the questions of charging current and regulation later on and now will take up the consideration of frequency and endeavor to determine the best frequency with loads such as we are to handle, that is :—

INCANDESCENT LIGHTING, ARC LIGHTING, POWER SERVICE BY INDUCTION OR SYNCHRONOUS MOTOR AND RAILWAY LOAD: With incandescent lighting while 30 cycles is the limiting frequency, 40 cycles is unsatisfactory

TABLE 1.—REPORT OF COMMITTEE ON HIGH TENSION TRANSMISSION.

Class.	Number of Plants	Transmission Voltage.			Total mileage of transmission lines	Total power transmitted in kilowatts	Length of Lines in miles.			Phase			Frequency, cycles per second:						Range of power-factor	Distance between conductors in inches		
		Maximum.	Minimum.	Average.			Maximum.	Minimum	Average	Single	Two	Three	25	30	33	40	60	66		Maximum.	Minimum.	Average.
A	19	12 000	4 600	8 000	217	31 135	25	3	9.5	1	4	14	2	1	2		14	2	80 to 100	36	14	19
B	7	16 000	14 500	15 000	297	65 425	31	7	23	—	—	7	2	1	-	1	3	—	80 to 97	40	18	27
C	9	24 000	20 000	22 600	394	64 999	60	107	32	—	—	9	2	1	—	—	5	1	80 to 90	48	26	33
D	4	27 000	25 000	25 500	127.50	23 400	46	16.6	32	—	—	4	-	—	-	—	3	1	80 to 90	50	18	39.5
E	1	34 000	30 000	31 300	276.50	[illegible]	83	29	62	—	-	4	1	-	—	1	2	—	90 to 95	40	24	31
F	1	60 000	40 000	51 600	28.25	14 875	101	60	75		—	1	—	1	—	—		—	65 to 100	108	42	76

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when moving objects are viewed by it. On this continent 60 cycles is the standard frequency for such a service, while 50 cycles is European practice. For arc lighting 40 cycles is the limiting frequency. Lower frequencies are made use of in the application of the recently developed mercury vapour converter and magnetite lamps. This new system, however, will probably have to go through a process of further experimenting. The conservative investor will still select the higher frequency series alternating enclosed arc lamps.

INDUCTION MOTORS: Analyzed from the standpoint of frequency, induction motors show characteristics which make it difficult to decide as to the best motor. Both motors under careful design can be made of equal performance as to power factor, efficiency, etc. But the motors will be of radically different designs. From the commercial standpoint the 60 cycle motors have a decided advantage, namely, a somewhat higher speed. Speed and cost are inversely proportional, hence the 60 cycle motor will prove the cheaper of the two. Another point which favors the 60 cycle motor is the greater demand for it, and the manufacturing companies have developed a finer design of this frequency. As a rule lower frequency motors are adaptations to standard 60 cycle frames and punchings, hence their performance does not show characteristics of the same high standard. Of course the low frequency motors have advantages of their own, such as better starting torque, higher instantaneous but not continuous overload capacity and lower speeds. As stated before, unless the motors of the lower frequency are standardized for best and most efficient design the high frequency motors are more satisfactory.

The principal factors in favor of the 60 cycle motors are better continuous overload capacity and also a cheaper product commercially as a result of higher speeds. Therefore, with equally good performance as to efficiency and heating, the 60 cycle motor will still be ahead of the 25 cycle motor.

Revolutions per minute—Synchronous speed.

Poles	2	4	6	8	10	12	14	16	18	20
25 Cycles—	1500	750	500	375	300	250	214	187	166	150
60 Cycles—		1800	1200	900	720	600	514	450	400	360

RAILWAY LOAD: The suitability of low frequency synchronous converters for railway work is a well established fact. While 60 cycle synchronous converters are used for such purposes, they are rather an exception and their operation is less satisfactory. What should then, under the circumstances, be a desirable way of supplying street railway loads without resort to frequency changers? The latter are out of the question, due to the excessive cost, besides the great reduction in the efficiency of the systems, resultant from their use.

Motor generator sets may be and are advantageously used in this connection, and while not possessing the advantages of 25 cycle synchronous converters, have features which make them particularly suitable for use on long distance transmission systems, permitting of a partial or complete control of the power factor of the system depending as to whether induction motors or synchronous motor sets are used.

Wherever large capacity is present, due to long transmission lines, induction motor generator sets of large size can be used to great advantage. For perfect control of the power factor of the transmitted power, synchronous motors should be employed, as in this case the regulating of the field excitation allows of a close control of the power factor of the transmitted energy, allowing the maximum energy for a given current, and under certain conditions will permit of carrying the load at unity power factor in the generating and transforming apparatus and transmission line.

While the sychronous converter is the most efficient

TABLE II.—TABLE OF REACTANCES.

Size of Conductor in B & S Gauge	Diameter in Inches	Resistance in ohms per 2,000 ft. of Wire at 68° fahr.	Reactance in ohms per 2,000 feet of Wire at a frequency of 60 cycles per second. Distances between centres of conductors in inches.													
			½	1	2	3	4	5	6	8	12	18	24	36	48	60
Solid 10	0.1018	1.994	0.116	0.148	0.1803	0.199	0.212	0.223	0.231	0.244	0.2626	0.281	0.294	0.313	0.326	0.337
8	0.1285	1.254	0.107	0.138	0.1695	0.189	0.202	0.212	0.220	0.233	0.2519	0.271	0.284	0.302	0.315	0.326
6	0.1620	0.7888	0.095	0.127	0.1589	0.178	0.191	0.201	0.209	0.222	0.2412	0.260	0.273	0.292	0.305	0.315
4	0.2043	0.4960	0.085	0.117	0.1482	0.167	0.180	0.199	0.198	0.211	0.2305	0.249	0.262	0.281	0.294	0.305
Strand 4	0.232	0.4960	0.078	0.111	0.1424	0.161	0.174	0.185	0.193	0.206	0.2247	0.244	0.257	0.275	0.288	0.299
3	0.260	0.3934	0.072	0.105	0.137[illegible]	0.155	0.168	0.178	0.186	0.199	0.2195	0.237	0.250	0.269	0.282	0.293
2	0.292	0.3120	0.067	0.099	0.1318	0.150	0.163	0.173	0.181	0.194	0.2142	0.232	0.245	0.264	0.277	0.288
1	0.328	0.2474	0.063	0.095	0.1261	0.145	0.158	0.169	0.177	0.190	0.2088	0.228	0.241	0.259	0.273	0.283
0	0.373	0.1962	0.056	0.089	0.1205	0.139	0.152	0.163	0.171	0.184	0.2029	0.222	0.235	0.253	0.267	0.277
00	0.418	0,1556	0.052	0.084	0.1153	0.134	0.147	0.158	0.166	0.179	0.1977	0.216	0.230	0.248	0.262	0.272
000	0.470	0.1234	0.046	0.078	0.1099	0.129	0.142	0.152	0.160	0.173	0.1923	0.211	0.224	0.242	0.255	6.265
0 000	0.528	0.09786		0.073	0.1046	0.123	0.136	0.147	0.155	0.168	0.1869	0.206	0.219	0.237	0.251	0.261
Cir. Mils.																
300 000	0.630	0.06902		0.064	0.0964	0.115	0.128	0.138	0.146	0.160	0.1788	0.197	0.210	0.229	0.242	0.253
400 000	0.728	0.05178		0.058	0.0898	0.109	0.122	0.133	0.141	0.154	0.1722	0.192	0.205	0.224	0.237	0.247
500 000	0.815	0.04042		0.053	0.0846	0.104	0.117	0.127	0.135	0.148	0.1670	0.186	0.199	0.218	0.231	0.241
600 000	0.893	0.03452		0.048	0.0804	0.099	0.112	0.123	0.131	0.144	0.1628	0.181	0.195	0.213	0.226	0.236
700 000	0.964	0.02958		0.045	0.0769	0.096	0.109	0.120	0.128	0.141	0.1593	0.178	0.192	0.210	0.223	0.233
800 000	1.031	0.02598			0.0738	0.093	0.106	0.116	0.124	0.138	0.1562	0.175	0.188	0.207	0.220	0.230
900 000	1.093	0.02300			0.0711	0.090	0.103	0.113	0.121	0.135	0.1535	0.173	0.186	0.205	0.218	0.228
1 000 000	1.152	0.02070			0.0687	0.087	0.100	0.111	0.119	0.132	0.1511	0.170	0.183	0.201	0.215	0.225
1 250 000	1.289	0.01657			0.0635	0.083	0.096	0.106	0.114	0.127	0.1459	0.164	0.178	0.197	0.211	0.221
1 500 000	1.412	0.01381			0.0594	0.079	0.092	0.102	0.110	0.123	0.1417	0.160	0.174	0.193	0.206	0.216
1 750 000	1.526	0.01183			0.0558	0.075	0.088	0.098	0.106	0.120	0.1382	0.157	0.170	0.189	0.202	0.212
2 000 000	1.631	0.01053			0.0527	0.072	0.085	0.095	0.103	0.116	0.1351	0.154	0.167	0.185	0.199	0.209

A	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.60	1.70	1.80	1.90	2.00
B	0.0022	0.0044	0.0064	0.0084	0.0103	0.0121	0.0138	0.0155	0.0171	0.0186	0.0216	0.0244	0.0270	0.0295	0.0319

For any other frequency f, the reactances given in the table must be multiplied by $\frac{f}{60}$

The reactances for diameters of conductors which lie between the sizes given can be found by direct interpolation.

The reactance for any distance D not given in the table can be found as follows: let d = the nearest smaller distance in the table. Divide D by d and taking a value of A nearest to the quotient find the corresponding value of B, which must be added to the reactance corresponding to the size of conductor and distance d.

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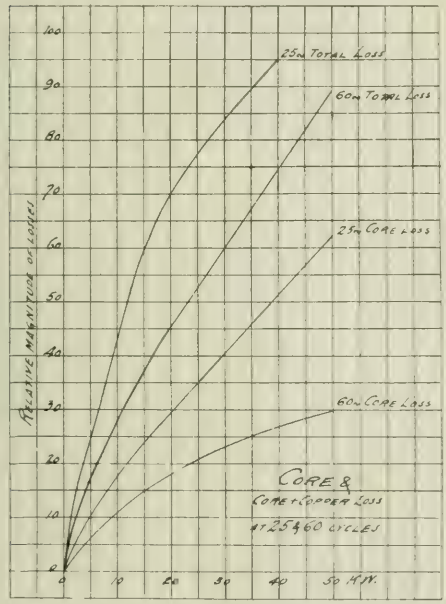
of the three means of supplying railway loads, whenever this load constitutes only the minor portion of the total output of the plant, the interests of the lighting and power load cannot be sacrificed for a most efficient conversion of the alternating current to direct current for railway purposes.

In our discussion of frequency we may conclude that for a mixed load of lighting and power with a railway load not exceeding one-third of the total power generated, 60 cycles will be the frequency to select.

We are to take up now two more questions. These are charging current and the regulation of the line. The above factors under adverse conditions will limit certain developments, making them impossible, commercially considered, at 60 cycles. The same development at 25 cycles may present a very attractive proposition using power for a different application.

Let us see how the two frequencies affect our case.



What will be the relative magnitude of the charging current and regulation?

Line 100 miles long.

Load 10,000 h.p. for each transmission circuit.

Conductor 4/0.

Voltage at receiving end 50,000.

Space between conductors 60".

Charging current at 60 cycles = 23 amps.

Charging current at 25 cycles = 9.6 amps.

Regulation 60 cycles.

160% P. F. full load 9.0%.

80% P. F. full load current 23.0%.

(Step up and step down transformers included in this calculation.)

Regulation 25 cycles (including transformer).

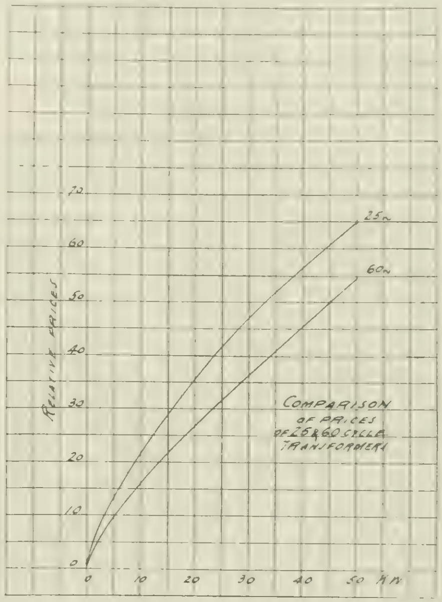
100% P. F. full load 5.5%.

80% P. F. full load current 10%.

The regulation and capacity or charging current are decidedly in favor of the 25 cycle transmission. The results for the 60 cycle system, while considerably in excess of those at 25 cycles, are considered quite normal for commercial purposes and inasmuch as the increase and decrease in the load is gradual the regulation is well within control of the central station operators or automatic devices.

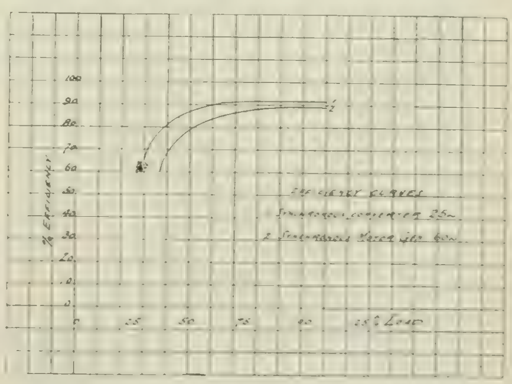
As to the railway load, this had better be carried on a separate circuit, whenever a multiplicity of circuits is used in transmitting the power. In our case there are three transmission circuits.

Considering the successful operation of one of the long distance transmission lines of 150 miles in California where the charging current forms 40% of full load current, and where the regulation is 40% at full



load, 80% power factor, we need not hesitate to operate our line with a regulation of 23%, 80% power factor.

The power factor of the system, however, is to a large extent within the control of the operating company, as it may recommend to power users such apparatus as will best answer the purposes of the system as a whole. Beside this, by employing synchronous motors running as rotary condensers, it will be enabled to regulate the power factor of the system and keep it if necessary at unity. These synchronous



motors running idle, used supplementary to the synchronous motor generator sets, will allow of a perfect control of the power factor of the system, reducing the regulation to 9% under full load conditions.

In conclusion, we will say, that under the conditions as stated, for a mixed lighting and power load, with a railway load not exceeding 33% of the total output, a 3 phase 60 cycle system should be employed throughout and all transformation should be accomplished by Δ to Δ connections.

CANADIAN

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AND ENGINEERING JOURNAL

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of his journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

To Subscribers. We appreciate very much the many kind expressions regarding the CANADIAN ELECTRICAL NEWS received from time to time from its subscribers. It would be of great assistance to us if those subscribers who have found the paper valuable and interesting would kindly recommend it to their neighbors and friends. We would like to add to our present list of subscribers at least 500 new names during 1907. The kind co-operation of our subscribers and friends for this object is solicited. Will every present subscriber make an effort to help us to the extent of sending us the name of at least one new subscriber during the coming year, or the name and address of some person who might be induced to become a subscriber.

Niagara Power in Toronto. At half-past five on Tuesday afternoon, November twentieth, the switches at the step-up transformer station at Niagara were closed for the first time, and current was sent over the wires to the step-down station in Toronto. The transformer switches were then closed, and the lights in the station became incandescent with Niagara current. The ceremony was very quiet, but few of the gentlemen interested in the Electrical Development Company being present, though that particular day will probably go down as one of the most important in the history of Toronto. The following afternoon a one thousand kilowatt rotary converter was placed in service and operated in parallel with the direct current machines in the Scott street station of the Toronto Electric Light Company, Niagara power being actually distributed in the centre of the city during the period of heavy load between four and six o'clock. Since then, a large rotary has been placed in operation by the Street Railway Company, and one of the twelve hundred horse-power synchronous motor-generator sets in the Terauley street station of the Toronto Electric Light Company has been thrown in. Progress, of course, has necessarily been slow, as all engineers familiar with the difficulties of changing over such an equipment will appreciate, and it will doubtless be many months yet before the Toronto Electric Light Company will be in a position to shut down their steam equipment. All has gone smoothly so far, and there is a noticeable difference in the lighting of the city. It has been an enormous pieceof work, and to the engineers in charge every credit is due for their painstaking efforts and careful solution of the many problems presented. As is well known, the main step-down station of the Toronto-Niagara Power Company reduces the voltage from sixty thousand to twelve thousand three hundred. From this station energy is distributed by underground three-phase cables to the various secondary substations in the city, out of which run both overhead and underground feeders. The figures of the Hydro-Electric Commission with regard to Toronto appear ridiculous, when one considers the enormous expense within the city itself which is necessary for a complete distribution. Recent data from the Commission gives a price of about sixteen dollars per horsepower for a total of thirty thousand, and we feel quite safe in saying that another twenty dollars per horsepower will have to be added to this figure to cover the

cost of distribution. We cannot understand why the Commission has persisted in misleading the public by quoting figures for power at the twelve thousand volt bus bars of the main step-down station, when they certainly and surely appreciate the fact that the cost of distribution in Toronto will be exceptionally heavy. We have as yet seen no data from the Commission covering the cost of this distribution, and we think it would be only fair to the people if the engineers in charge immediately prepared and presented the cost of this work, instead of continuing to misinform them. When the price of sixteen dollars is presented before an engineer, together with information as to what this means, he appreciates that there is yet distribution to be figured upon, but the public knows nothing of such matters. In the meantime, the Electrical Development Company has commenced the operation of its machines after some five years' work at Niagara, and the Toronto Electric Light Company has its entire system of distribution ready and in service. No thoughtful business men will hesitate to enter into contracts with the companies now in operation, appreciating that the statements of the Hydro-Electric Commission are misleading and wide of the mark.

Sodium as a Conductor.

A very interesting paper has recently been prepared covering the use of sodium for electrical conductors, to replace copper and the other metals now used for this purpose. The present condition of the copper market and its apparent tendency are such as to make engineers give serious consideration to other materials, and investigations have therefore been carried on with a view to perfecting some substance which can be used instead of copper. A table is given below showing the relative conductivities of various metals, the first column being prepared on a weight basis and the second on a volume basis :

Metal.	Conductivity by weight.	Conductivity by volume.
Sodium	115.	31.4
Calcium	100.	45.1
Potassium	86.8	22.1
Aluminum	80.4	63.0
Magnesium	75.5	39 4
Copper	37.5	97.6
Silver	32.5	100.0
Gold	13.6	76.6
Zinc	14.5	29 6
Cadmium	9.7	24.4
Cobalt	6.8	16.9
Tin	6.7	14.4
Iron	6.3	14.6
Nickel	5.0	12.9

Sodium, it will be seen, has the greatest conductivity per unit of weight, and hence the possibility of using this material has been given serious consideration. The general process of constructing sodium conductors is to take standard wrought iron pipes and heat them to a point well above the melting temperature of sodium. The sodium is then melted in special kettles and run into the pipes, and when the metal cools the sodium becomes solid. Joints can be made between lengths of pipe in various manners, this being at the most a simple mechanical problem. There seems to be no marked depreciation of either the sodium or the pipe if the latter be properly protected by a coat of weather-proof paint. There are, of course, certain disadvantages in the use of sodium, one of which is the violent action which takes place when brought into contact with water. In the event of fire, there is the chance of the pipe bursting and allowing the sodium to run out, under which circumstance it would merely burn, but if water should be brought in contact with the metal, a more serious condition would result. For overhead transmission lines or feeders for heavy railway work, this objection is not serious, and it seems quite possible that the sodium conductor will find a large field in such work. For the same conductivity, the price of the complete sodium conductor is considerably lower than an equivalent capacity of copper, costing in small sizes not more than fifty per cent. of the cost of copper, and in large sizes not more than twenty per cent. Figures have been presented covering various sizes of sodium conductors with comparison of an equivalent amount of copper. For instance, a one-half inch wrought iron pipe filled with sodium has a capacity of one hundred and nine amperes, and the total cost of the materials is in the neighborhood of three and one-half cents per foot. The same conductivity in copper would cost approximately eight and one-half cents. For a carrying capacity of eight thousand one hundred and thirty amperes, a six inch wrought iron pipe is used, and the cost per foot of such conductor is given at one dollar and thirty-eight cents, whereas a copper conductor would cost six dollars and twenty-one cents. The above figures are estimated on the basis of seven and one-half cents per pound for sodium, and sixteen cents per pound for copper, which, as will be appreciated, are in both cases lower than the present market price of the metals.

Rural Transportation.

The difficulties encountered in obtaining a cheap but efficient system of freight and postal delivery in rural sections has so far prevented any material success in this particular field. The interurban railway has played an important part in such matters, and is, of course, highly successful, though to justify the expenditure required for the construction of such an undertaking, the communities which it serves must be fairly well built up. Automatic devices of various kinds have been tried with limited success, for it appears to be essential to put the cars under the direct control of an operator who must necessarily travel with the car. When one considers the success which has been obtained in the manufacture of various articles by machines which are automatic in every sense of the word, it does not seem improbable that some day similar ideas may be incorporated into a system for rural freight delivery. A company is now being floated in Canada and the United States which has for its purpose the establishment of an automatic transportation system, the idea being to handle incoming and outgoing mail and freight of every description. A model of this system is now being exhibited in the city of Toronto, and the idea as presented seems to be quite feastible when carried out on a small scale. Success, of course, has been obtained in collecting mail bags by a fast moving train, and the system just mentioned is being worked out along somewhat similar lines. So far as the postal end of the scheme is concerned, the feasibility of the idea is apparent, because for this work the weights to be handled will always be small, and letter boxes can be picked up and

dropped without material jar to the car itself or to its supporting structure. Any entirely automatic system must necessarily include tracks which are elevated a considerable distance above the ground, and while the cost of such structure is quite low where small weights are to be handled, still the expense will, we think, be a very serious item where heavy weights are concerned, and the possibility of picking up and dropping such weights from a moving car will bring forward many arguments against the system. The transportation scheme just mentioned includes a system of control whereby all cars are manipulated by an operator at the central point, and a modification of the block signal has been adopted so that the operator will know at any instant the exact position of all cars. Difficulty will be experienced, however, in keeping such cars properly spaced, as the speed of one, heavily loaded, will be considerably less than that of one running light. Slowing down and stopping at certain predetermined stations will also be another difficulty, for the cutting off of the current and the braking action must take place at some set point, and allowance cannot be made for the condition of the rails. In other words, assuming for the sake of argument that the car is carrying a fixed load, if it be desired to stop or run slowly past a certain station, the brakes will be applied and the current cut off at a fixed number of yards before that station is reached. If the rails at this point are covered with ice, we cannot see what there is to prevent the car running past the station, and as there are no reversing appliances the car would undoubtedly pass on to the next station without delivering its freight. However, we must commend the spirit which has led the inventors to make a practical demonstration of the scheme, and we sincerely hope that the matter will prove satisfactory under actual working conditions.

ENGINEERS' CLUB OF TORONTO.

The Engineers' Club of Toronto have decided to sublet their rooms at 96 King street west to the Toronto Branch of the Canadian Society of Civil Engineers, one meeting a month to be held by the members of the society. The members of the Engineers' Club who are not members of the C. S. C. E. are to become associate members, and with this be afforded the privilege of attending the monthly meeting of the Toronto branch of the society.

CHIEF ENGINEER PACKARD ELECTRIC COMPANY.

Mr. H. A. Burson has recently been appointed Chief Engineer of the Packard Electric Company, Limited, St. Catharines, Ont. The Company are making extensive alterations in their works, not only with a few of ncreasing the output of their present lines of manufacture necessitated by the rapidly growing demand, but also to add other lines of apparatus which will in due course be offered to the trade.

Mr. Burson graduated in Electrical Engineering at McGill in 1901, receiving the degree of B. Sc., and from 1901 to 1903 was Demonstrator in the Department of Electrical Engineering under Prof. Owens, and received the degree of M. Sc. for original research work. In the spring of 1903 he went to the Bullock Electrical Manufacturing Company at Cincinnati, where he was associated with Mr. B. A. Behrend, Chief Engineer. In 1904 he was appointed Chief Electrical Engineer of Allis-Chalmers-Bullock, Limited, at Montreal.

In his capacity as Chief Engineer of the Packard Electric Company it is safe to assume that, with the assistance of his staff of able and competent shop men, the present products of the Company will be brought up to the highest standard, as will also the new lines of apparatus which the Company will shortly put upon the market.

CANADIAN STREET RAILWAY ASSOCIATION.

The semi-annual convention of the Canadian Street Railway Association was held at the King Edward Hotel, Toronto, December 6th and 7th, at which most of the large companies were represented. The following papers were presented :

"Some of the Methods in Vogue in Modern Railway Shops," by W. R. McRae, master mechanic of the Toronto Railway Company ; "Track Construction, Maintenance and Repair," by A. M. Grantham, C.E., Toronto Railway Company ; "Discipline," by J. E. Hutcheson, Ottawa Electric Railway Company ; "Standardization of Equipment," by C. B. King, manager London Street Railway ; "Freight and Mail," by E. F. Seixas ; "Columbus Convention," by A. H. Royce, secretary of the association ; "History of Electric Traction in the Province of Ontario," by Robert Clarke, Toronto Railway Company ; "The Power House," by J. C. Rothery, of the East Liverpool, Ohio, Traction and Light Company.

LEGAL.

Gloster Vs. Toronto Electric Light Company.—The Supreme Court gave judgment on November 23rd in the case of Gloster v. Toronto Electric Light Co. This was an appeal from the Court of Appeal for Ontario. It is allowed with costs of Supreme Court and of Court of Appeal and the judgment of the trial judge is restored.

The action was brought to recover damages sustained by an infant boy of eight and one-half years of age through his hand coming in contact with an uninsulated wire of the defendant company carried near to the Glen Road bridge in Rosedale, Toronto. This bridge had shortly before the accident been reconstructed and widened at the upper part over which the public passed by the township of York under special legislation passed for the purpose.

Before the bridge was so widened the defendants' wires were stretched across this ravine, but at a distance from the bridge which prevented any such accident occuring, and it was the widening of the bridge which brought it and the wires to the close proximity which existed at the time the accident occurred.

At first trial of the case Cornelius Gloster, father of the boy, was awarded $800 and his boy $1,700 damages against the company. The Appeal Court reversed this in favor of the Toronto Electric Light Company, finding it was not guilty of negligence in the placing of the wire. The case was then carried to the Supreme Court when argument was heard on November 9th. Charles Millar, of Toronto, and J. D. Macdougall, Ottawa, appeared for the plaintiffs, and Hellmuth & Smith for the respondents.

Mr. Millar in his argument claimed that the company was guilty of negligence, and the live wire as placed a danger to the public. No warning was given, and, moreover, the company could easily have placed the wire differently. He contended that the boy on leaning out of the bridge, when he came in contact the wire, was making ordinary and lawful use of the bridge.

Mr. Hellmuth contended that the boy must have had the intention to touch the wire in leaning from the bridge. He further pleaded that as originally placed the wires were at a safe distance, and that the widening of the bridge, of which his company had no notice, brought the public within the danger zone. He claimed that the case was not a probable accident.

Mr. Millar, in closing, declared that the company were bound to inspect the wires, and lack of inspection constituted neglect.

S. P. S. ELECTRICAL CLUB.

A meeting of those interested in the formation of a club for the discussion of engineering subjects of direct interest to senior mechanical and electrical students of the Faculty of Applied Science of Toronto University was held in the engineering building on Thursday afternoon, December 6th. It was decided to form a club, to be called "S. P. S. Electrical Club," and the following officers were elected: Hon. President, Dr. Galbraith; President, Wells Maclachlan; Vice-President, F. R. Ewart; Secretary-Treasurer, J. C. Armer; Fourth Year Representative, N. P. F. Death; Third Year Representatives, G P. Coulter and C. H. Hutton.

These officers constitute the Executive Committee, and this Committee was given power to draw up the constitution.

Critics were elected as follows:—Prof. Roseburgh, Prof. Angus, H. W. Price, B.A.Sc., W. W. Gray, B.A.Sc., H. G. Smith, B.A.Sc., and S. Dushman, B.A.

The need for such a club has long been felt by the senior students, and the enthusiasm displayed at the organization meeting is an omen for the success of the club.

OSMIUM FILAMENT LAMPS.

Very marked progress has been made on the Continent in the development of the Osmium filament lamp. The chief difficulty experienced lay in the high conductivity of the filaments, rendering the production of lamps to suit our standard voltages practically impossible, owing to the exceptional length and firmness of filament required. Thirty-seven volts was about the maximum which could be accommodated at any lamp terminals, and it seemed for some time as if the Osmium lamp would on this account never be suitable for standard electric lighting purposes. Happily the labours of research have been most successful, and Osmium filament lamps having terminal voltages up to 200 volts and of medium candle-powers are an accomplished fact.

Some interesting data regarding the structure and performance of these modern lamps were presented at a recent meeting of the Elektrotechnischer Verein, in Vienna, by Mr. A. Libesing. The paper dealt mainly with a particular make of Osmium lamp known as the "Osmin." The filaments have a diameter of about 0.03 m.m. Tests on lamps of 54 volts showed an initial performance of 1.21 watts per c.p. After burning 1,776 hours the average over the whole time was 1.22 watts per c.p., and the candle-power had not fallen below 80 per cent. of its original value. "Osmin" lamps have also been produced which showed a consumption of as low as 0.55 watts per c.p., but no statement was made as to the life of those examples.

Interesting details are given of metallic filament lamps as compared with carbon filament lamps, as efficient light radiators. Apart from the fact that metallic filaments can be worked at higher temperatures than carbon, and so permit of a greater efficiency, it is pointed out that with metallic filaments the proportion of light-giving or visible radiation to heating or invisible radiation is larger than with carbon filaments. This is an extremely valuable property, tending towards the ideal lamp which shall give light without heat. The candle-power of Osmium filaments as compared with carbon filaments per unit surface, and with both filaments working at 1.55 watts per c.p., is about as 3 is to 8.

Another type of Osmium lamp is that known as the "Osram," which has been developed in Germany, and of which some details have been published in a recent issue of the Elektrotechnische Zeitschrift. This lamp is manufactured for voltages up to 130 volts, and of power up to 50 c.p. The following tables, published in the Electrician, are the results of tests made by the Reichsanstalt, and may be taken as reliable and authoritative. For the purposes of these tests, eight lamps of each size were taken haphazard from a large number. Of these sixteen, five failed just under 1,000 hours burning; the remainder survived the full period.

It would appear, from the figures obtained, that it can rightly be claimed for the "Osram" lamp that it has an approximate life of 1,000 hours, and a maintained efficiency closely approaching 1 watt per candle-power.

Hours of Burning.	Mean Voltage (volts).	Mean current (amperes).	Mean horizontal c. p.	Mean consumption per mean horizontal c. p. (watts).
1.—25 c.p. Lamps.				
0.4	117	0.272	28.5	1.11
100	117	0.272	29.6	1.07
200	117	0.271	29.8	1.06
400	117	0.270	28.7	1.11
500	117	0.270	28.1	1.12
700	117	0.270	27.7	1.14
1000	117	0.269	26.6	1.18
Alteration after 100 hrs....	--	—1.1%	—6.6%	+6.3%
Best lamp after 100 hrs....	117	0.270	27.3	1.10
Worst lamp aft'r 100 hrs....	117	0.267	25.7	1.22
2.—32 c.p. Lamps.				
0.4	112.75	0.314	31.9	1.10
100	112.75	0.315	33.7	1.06
200	112.75	0.316	33.9	1.04
400	112.75	0.314	33.0	1.07
500	112.75	0.314	32.7	1.08
700	112.75	0.311	31.3	1.12
1000	112.75	0.309	30.6	1.14
Alteration after 100 hrs....	--	—1.5%	—4.0	+3.6%
Best lamp after 100 hrs....	114.0	0.310	32.0	1.10
Worst lamp aft'r 100 hrs....	111.5	0.304	29.0	1.17

There seems to be a good prospect of the Osmium lamp of suitable candle powers and voltages, of long life, and of a consumption of 1 watt per candle power, becoming the standard electric lamp in the near future. Such a lamp would ensure lighting by electricity being produced as cheaply as by gas with Welsbach burners; and of course all the other present advantages of electric lighting would still be maintained.

The Bell Telephone Company made an offer to the City of London, Ont., of $3,500 per annum for an exclusive franchise for a period of five years or longer. This is an increase of $1,000 over the amount now being paid.

THE HUMAN SIDE OF THE ENGINEERING PROFESSION*

(AN OUTLINE)

By V. Karapetoff, Cornell University.

FUNDAMENTAL THOUGHT: Professional usefulness and personal satisfaction depend on the right conception of life and on the degree in which this conception of life is manifested in daily activity.

PART I.—WORK AND CONDUCT.

There are three essential requisties for an efficient and successful engineer:

A. Sound professional knowledge;

B. Knowledge of business forms and of human relations;

C. Good and strong character.

A. Professional Knowledge. A man who knows only "how" to do certain things, but does not know "why" they are done so, usually remains in subordinate positions. Get into the habit of analyzing; also, have your knowledge systematized.

In order not to get "rusty" you ought to do some study, or at least some reading outside of your daily routine work. This outside work may be classified, in an ascending scale of difficulty, as follows:

1. Keep notes on your regular work, with sketches, samples of calculations, etc. On separate notes keep matters of doubt to straighten them out at a future opportunity.

2. Read regularly at least one periodical relating to your specialty, and keep some kind of a general index on at least one subject in which you are particularly interested.

3. Be sure about the fundamental laws, facts, and assumptions on which your branch of engineering is based. If you are but recently from college, you can go over your old books and notes; otherwise read a good modern text book.

4. Gradually get familiar with more advanced books treating of the various branches of your profession; go from time to time to the public library and see if there is anything new in your specialty.

5. Select some one branch of engineering, if possible somewhat different from that in which you are regularly engaged, and devote some time to it. Know more than the next fellow does; it will pay you.

6. Do not miss any chance to make an original investigation; this will develop your thinking, increase your self-confidence and raise your standing in the profession.

7. Inventing is the highest form of the engineering activity; there is no reason why you should not bring some improvement into the work in which your are engaged. Concentrate your mind on one thing, work patiently and persistently, and you will be sure to achieve something that will be new and useful.

B. Knowledge of Business Forms and of Men. You naturally expect some day to occupy a responsible position in your profession. This is impossible without a sound knowledge of established business forms and of human relations in general. Here again there are several stages of study and observation. Take up as many of them as your ambition, time, and ability will allow.

1. Observe the characters of men you are working with; in particular, the influence of their previous experience and education, of their age and temperament, of their views on general life questions, etc.

2. Observe things that make them efficient and happy, or that are impediments in their work; things that they would like to have and the main things that they object to.

3. Observe critically your superiors and their ways of acting towards their chiefs and subordinates. Do this without malice, but rather with a sincere desire to find out the best way of conducting the work, when you shall be called to perform their duties. Make for yourself a clear mental picture of an ideal man in a certain position, and try to follow this ideal in your own business life.

4. Observe and read about general business systems adopted in large modern commercial and industrial enterprises; in particular,

(a) Subdivision of the duties of various officers, and their correlation;

(b) Correspondence, accounting, orders, receipts, etc.;

(c) Causes of loss, waste, inefficiency, etc., and possibble remedies.

Merely knowing the facts is not sufficient: you must see cleaely the necessity for a certain organization. Only then will you find a right place in it for yourself and efficiently discharge your duties.

5. Do not get "rusty" on general life questions; read books on history, economics, philosophy, etc., with the view of finding the underlying facts and motives in human relations. Do not adhere too readily to a traditional school; work out your principles for yourself, and be willing to change them when new evidence is laid before you. A man in a responsible position must be a well educated man; he meets a great many men, and has to face new situations. Therefore he must be well informed on things in general, and ought to be able to judge about them.

C. Training of the Character. Engineering and business knowledge are the necessary conditions for usefulness ("success" and usefulness are not always the same), but the proper development of the character is the third necessary condition.

What is the use of having a profound knowledge of engineering, if you have not the necessary perseverance to achieve results; or to have a knowledge of business forms and relations, if your temper is such that nobody cares to be associated with you in business.

Practice daily the qualities of the character tnat you find essential for a good citizen and a good business man.

1. Work patiently on any problem until a result is achieved. If it should be impossible to get satisfactory results, at least make clear to yourself the nature of the hindrances.

2. Be honest in all things; do not be afraid to confess your mistakes or your ignorance. Train your character by doing your work cheerfully.

*Abstract of an address delivered before the New York Electrical Society, October 31st 1906.

3. Keep down your selfish personality and ambition. Do not let them interfere with your business. *The highest goal of personality and ambition is to have your part of the work done in the most ideal way.*

4. Be generous, polite, and considerate to others ; there are no circumstances where you would be justified in breaking this rule. Remain dignified even under unjust reproof.

5. Work with the understanding that your activity of today shapes your future. You need not trust to chance ; *your opportunity will come when you are ready for it.*

PART II.—UNDERLYING MOTIVES.

(A THEORY OF LIFE.)

Some men are happy and efficient in their work without having any clearly defined conceptions of life and its purpose. In a great majority of cases, however, a lack of a workable theory of life brings with it a decrease in possible efficiency and in personal satisfaction. It is of importance, therefore, to know.

A. What are the principal limitations and wrong beliefs that are hampering engineers in their work.

B. How these limitations can be removed by working out a theory of life that gives a general meaning to man's activity.

C. How an engineer's work is shaped, when his underlying motives are illumined by such a theory of life.

A. USUAL LIMITATIONS that prevent an engineer from being fully efficient and happy in his work.

1. Belief that he is underpaid ; abnormal striving after money.

2. Belief that his efforts are not appreciated by his employer ; also that there is no chance for promotion.

3. Lack of knowledge, theoretical or practical ; lack of general education ; a deficient knowledge of business forms and human relations. This is often accompanied by a belief that he has no time for study ; in cases where a man has not exercised his mind for a long time, he has also to contend with his own mental apathy.

4. Deficiencies in character, such as weakness, roughness, egotism, narrowness, pedantry, absent-mindedness, laziness, etc.

5. Lack of enthusiasm due to the absence of a guiding and unifying purpose in life. This is particularly noticeable in very young men who are just beginning to form their own conception of life, and in older men who already see the end of their usefulness and cherish no more illusions.

B. A THEORY OF LIFE. Each man must work out for himself a practicable theory of life ; this will make his acts and words, thoughts and feelings, harmonious and consistent. The experience of humanity past and present is the material to work on; his reason is called upon to interpret this, and his conscience is the court of final appeal.

The following is *an example* of such a theory of life : (*)

(*) It may seem presumptuous on the part of the writer, who is not a philosopher by trade, to formulate a "theory of life" ; this he gives, however, simply in order to illustrate what a practical doctrine of life (not a "canned" religion) may be. For the author personally this doctrine is the truth he believes in and according to which he tries to shape his life ; for others it may serve merely as an example. He hopes that by criticizing his metaphysics readers may make their own conceptions on the subject clearer to themselves, and in this way be indirectly benefited even by a theory presumably wrong.

1. The Universe, including man, is governed by an Infinite Intelligence, which is manifested in man as his conscious life. There is no meaning in a man's life if it be detached from other men's lives. In proportion as he becomes conscious of this one, infinite life, common to all men, his own life becomes reasonable and harmonious, and the fear of poverty, sickness, old age and death gradually disappears.

2. The highest purpose of life is to work for the realization of the above ideal conditions of life on earth. We do this either by actually removing certain hindrances and fetters (practical work), or by making this great work clearer to others (literary, educational work, preaching, etc.).

3. Once this attitude is understood, the real compensation for the work consists, not in money and notoriety, but in the state of consciousness reached. This is manifested in particular :

(a) In a clear and definite program of life, and a ready answer for all difficulties (doing your best).

(b) In a state of harmony and good fellowship with all men, through the understanding of that life which is common to all.

(c) In a freedom from fear, anger, jealousy, apathy, and other limitations caused by the assumption that life is an accidental chain of phenomena and circumstances.

WORK ILLUMINED BY HIGHER IDEALS. Once he has obtained a workable life-theory, all of the limitations enumerated above, that prevent an engineer from being efficient and satisfied in his work, can be removed by actually applying this theory to his daily work.

1. The belief that he is underpaid or not appreciated enough loses its power ; the man works no more for a company or corporation. He works for his conscience sake, and finds his true compensation in the results of his work.

2. He is full of desire to do as much as he can, and not as little as he is allowed to. For this reason he wants to know much and have his knowledge in a practical form, ready for use. He is active and studious all the time, and the expression "mental lethargy" is incomprehensibe to him.

4. He frees himself from possible shortcomings in his character by keeping the ideal of perfection continually before his mind's eye. He no longer finds difficulty in handling men and in treating his co-workers and chiefs aright ; he has a sincere ympathy for them, tries to help them, and to make their work more pleasant and efficient.

5. He is full of enthnsiasm, for he is aware of the infinite importance of his life and work. His work is infinite as is Life itself ; and each problem solved brings with it a higher and more important problem, brings more truth and light into his consciousness.

CONCLUSION—(*Credo*).

1. Make yourself ready for a broader and higher field of activity ; then your opportunity will surely come.

2. The true purpose and value of engineering activity lie in providing better and easier ways for satisfying ordinary human needs. This provides more leisure and opens new possibilities for a higher spiritual and intellectual devlopment of humanity.

3. The engineer's personal satisfaction consists in knowing this high purpose of his vocation, and in giving his service at a maximum efficiency. The other compensation is a result and not the purpose.

UNDERGROUND CABLES.*

By H. G. Stott.

The use of underground cables for the transmission of power by electricity has become so universal that no apology is necessary for bringing before the members of this association a few points which seem to the author to have failed to receive the attention they deserve.

Underground cables, as used by the members of this association, may be grouped into three classes, viz. :—

1. High-tension multiple or single-conductor cables of relatively small-current carrying capacity, but capable of operating under working pressures from 2,500 to 25,000 volts mean effective pressure.

2. Low-tension single conductor cables of large current-carrying capacity, but only operating under pressures of 650 volts or less.

3. Negative return cables of large current-carrying capacity, but only operating under a pressure corresponding to the drop in the return feeders.

The first class, comprising what is popularly known as high-tension cables, has developed by a process of evolution from the time when nothing but rubber was used for insulation, to the present time where rubber, varnished cambric, saturated tapes and paper insulation have been brought to such a state of perfection as to leave little to be desired.

Higher voltages than 25,000 have not been attempted as yet in underground cables, but there seems to be no reason why a voltage of 44,000 should not be used with exactly the same degree of safety as 25,000, provided a star connection is used in the transformers and the neutral point is grounded, for then the maximum strain is limited to 25,000 volts to ground. It would thus seem that our cable manufacturers have almost kept up with the development in overhead construction, as at this time 60,000 volts is the maximum pressure in use in a few cases only, and the great majority of important transmission schemes are under 50,000 volts.

For economic reasons, principally, rubber insulation is only used where local conditions seem to demand an insulation which is impervious to moisture, so that in case the lead sheath should be punctured, the cable will not necessarily fail.

As an instance, where cables have to be installed in ducts which are under water part of the time, or for submarine cables, the extra investment for rubber insulation would seem to be justified, as in the event of a leak in a submarine cable lead sheath it usually becomes a total loss if insulated with paper or other non-moisture-proof material, whereas good rubber will last indefinitely under water.

For potentials above 22,000 volts it seems likely that some form of varnished cambric or impregnated cloth will take the place of paper, owing to its higher puncture resistance for a given thickness, but experience with working pressures above 22,000 is so limited that we must wait for some time before any definite conclusions can be reached.

As the result of some 15 years of experience with underground cables, the following table, giving thickness of insulation and lead sheath for various sizes of conductors and working pressures, is submitted as representing conservative practice :

*Abstract of a paper read at the Columbus Convention of the American Street and Interurban Railway Engineering Association.

Table I.—Paper Insulation. Standard Working Pressure of 3,000 Volts.

Size of Conductors.	Thickness of insulation	Thickness of lead. Single cond.	Three cond.
No. 6 to No. 2 B. & S.	5-32 in.	5-64 in.	3-32 in.
No. 1 to No. 00	5-32 in.	3-32 in.	7-64 in.
No. 000 to 300,000 cm.	6-32 in.	7-64 in.	9-64 in.
400,000 cm. to 750,000 cm.	6-32 in.	7-64 in.	..
800,000 cm. to 1,000,000 cm.	7-32 in.	4-32 in.	..
1,250,000 cm. to 2,000,000 cm.	8-32 in.	9.64 in.	..

For each 1,000 volts increase of pressure above 3,000 add 1 32 in. insulation to the wall until 11,000 volts is reached, and after that add 1/64 in. for each 1,000 volts. For example, the insulation required on a No. 0. B. & S. 25,000 volt cable would be 20/32 in. or 5/8 in. If 35 per cent. para-rubber compound or varnished cambric is used for insulation, the above empirical rule may be changed to read : For each 1,000 volts increase above 3,000 add 1/64 in. insulation to the thickness of wall until 25,000 volts is reached. For the insulation of low-potential cables in class II, 4/32 in. paper should be used on all sizes up to 1,000,000 cm., and from 1,250,000 cm. to 2,000,000 cm. 5/32 in. should be used.

From a purely electrical point of view one-half of this insulation would be ample to withstand 650 volts working pressure, but the mechanical effects of reeling and unreeling the cable and pulling it into ducts and bending around manholes, are to practically destroy the insulating qualities of the layer of paper next the lead, so that we really start in with a cable having approximately 1/32 in. of its insulation destroyed before it is put into commission; this mechanical destruction of insulation is especially marked in cold weather, as the oils used with the paper tend to congeal when subjected to a temperature below 32°F. The cable manufacturers have met this difficulty by using more fluid oil, with the result that the insulation resistance of the cable may not be more than 50 megohms at 60°F., but by the use of this very soft insulation they have produced a cable giving a very low insulation, but a high puncture test, and at the same time have met, to a great extent, the difficulty of handling paper cable in cold weather. It is always advisable, however, if a cable is to be used in a temperature below 32°F. to keep it in a warm place, such as a boiler room, for at least twelve hours before drawing it in. The cable may then be used in the coldest weather, as it gives up its heat very slowly.

Class III cables have up to within the last three years received very little attention, as, in almost every case, bare copper cables were installed. But a closer study of the electrolysis problem indicates that in many instances the use of insulated negative cables would eliminate a great deal of the trouble and damage to cable sheaths, &c.

If bare copper returns are used, return currents may flow back by the lead sheathing of the feeder. An obvious remedy would seem at first sight to be the bonding of lead sheaths of all feeders to the bare negative cables at frequent intervals, but this introduces another trouble which may be as serious as electrolysis. A short circuit in a positive feeder, to ground, will cause an enormous current to flow through the lead sheaths, and in all probability burn off the bonds and destroy the lead sheaths in a number of cables. Instances of this have occurred to the author's knowledge, in which the lead sheaths have been completely burned off for 400 ft. on cables that were entirely innocent of the origin of the trouble.

Another source of trouble, due to the use of the grounded negative 'bus and bare feeders, is in the other feeder's lead sheaths carrying the negative current back to the power house or sub-station by an entirely different route from that taken by the bare negative feeders, with the result that this return current leaves these lead sheaths, either in the power house though a ground put on them, or through some accidental ground, such as a cable hanger in a manhole. Every time a short-circuit comes on the system a rush of current will flow through these lead sheaths, and perhaps puncture small holes in the lead.

The most satisfactory solution of these problems of avoiding electrolysis and saving the lead sheaths from destruction seems to be in the use of an insulated negative 'bus in the power house and sub-station, and insulated negative feeders right up to the track rails. For this purpose the negative feeders should preferably be insulated with some material which does not require the use of a lead sheath. Several types of insulation are now on the market, which promise to be very satisfactory for this purpose, as the potential carried by the negative feeders is quite low.

The ideal solution of the problem would be found in the use of the feeders without lead sheaths, and some very satisfactory tests are now being made on experimental lengths of 650 volt cable of this type, but it does not seem probable that any cable can be constructed at present which will safely stand being drawn into wet ducts and manholes and used continuously on pressures above 2,000 volts without the protection of a lead sheath to keep out the moisture.

By using insulative negative feeders and avoiding all earthing in the power house or sub-station, it is evident that there will be little or no tendency for the return current to leave the track rails, if properly bonded, and absolutely no tendency for stray currents to come back to the power house or sub-station by way of lead sheaths, gas mains, etc., thereby relieving us of probably 75 per cent. of our present electrolysis troubles.

Coming back to Class II cables, the safest plan seems to be to insulate the lead sheaths of all feeders by supporting them on racks having some form of insulation between the lead sheath and the hanger.

All cables should also be wrapped with two layers of ⅛ in. asbestos in every manhole where more than one cable is on each side, in order to afford protection from an arc caused by any one of them burning out. In perfectly dry places this asbestos wrapping can be secured very neatly by applying silicate of soda to it, the soda in itself being a good protection against fire; in the average damp manhole this soda will soon loosen and the asbestos wrapping will fall off, so that, in this case, a galvanized steel tape about ⅝ in. by 1/32 in. should be used to hold the asbestos in place.

In order to get early warning of the breaking down of any positive feeder, and so give time to have it cut out before doing any further damage to itself or neighbors, a small insulated wire (say No. 14 B. & S.) should be connected to the lead sheath and brought up to a panel where the switchboard operator can see it. On this panel may be mounted one or two lamps for each positive feeder, and these lamps connected to ground through a resistance large enough to limit the current to the amount necessary to light the lamps when the pilot wire attached to the lead sheath to any feeder becomes alive through the grounding of that feeder on its insulated lead sheath. Ammeters or relays operating a gong may also be used with advantage for this purpose at a very small cost per feeder.

In reference to Class I, or high-tension three-phase cables, their lead sheath should be insulated and wrapped with asbestos in the same manner as described for Class II, with the additional precaution that their lead sheaths should all be bonded together and grounded in the generating plant. The neutral or star point of the generators or transformers should be grounded through a resistance of such dimensions as to limit the current flowing through it when an earth occurs on a high-tension feeder, to the amount necessary to trip the overload relay. For example, on a large installation using 11,000 volts for distribution to its sub-stations, the neutral connection is one having resistance of 6 ohms, and a carrying capacity of 1,000 amperes for one minute. As the Y potential to earth is 6,300 volts, this limits the current to a maximum of 1,000 amperes, when the feeder becomes earthed.

This system was adopted after some rather disastrous experiences with short-circuits on high-tension feeders, and has been in successful operation for over a year.

When a high-tension cable breaks down it almost invariably goes to earth from one phase only, and then after the charging current of the whole system has been flowing to the earth through this fault for perhaps 10 or 20 minutes, the insulation of the other phases is burned off, so that a short-circuit on two or three phases occurs, with the result that either the whole system is shut down, due to the sudden fall of potential, to perhaps one-fourth of its normal value, or at least one or two sub-stations are shut down from the same cause. With the neutral grounded through a suitable resistance, the oil switches, on the grounded feeder only, trip out quietly without any disturbance whatever to the rest of the system.

If the three-phase high-tension cables are not grounded in the generating plant, the burning out of a cable will puncture the lead sheath at a number of points, possibly 1,000 ft. away, as it is obvious that the current must leave the lead sheath somewhere, and the easiest path is usually found at cable hangers in the manholes. This will be true no matter whether the neutral is grounded or not.

As a further precaution, it is advisable to bond the lead sheaths of the alternate-current feeders quite frequently in the manholes by wiping on a lead strap, say ⅛ in by 2 in. to the lead sheaths. Bonding by wrapping the lead sheaths with a few turns of copper wire is worse than useless, as the copper wire, if put on tight enough to make a good connection, may cut through the lead, and if not tight enough to do this, it will probably make such a poor contact as to arc when current passes.

In conclusion, the author wishes to state that, in his opinion, at least 75 per cent. of cable trouble is caused by defects in the lead sheath and not by defects in the insulation.

Examine the ordinary vitrified duct and you will find that the inside, in all probability, contains several small hard sharp points projecting from 1/16 in. to ⅛ in. What happens to the lead sheath of a cable when it passes over these projections? A groove is cut in it in exactly the same way as by a tool in a planer. The result is that a little extra pressure, caused by a kink in the cable, will cut through the lead and admit the moisture, which, sooner or later, will destroy the insulation.

Beyond trouble in joints caused by carelessness on the part of the jointer, practically all cable trouble can be eliminated by the more careful choice and installation of conduits, by a very careful inspection at the time they are laid, and by the use of cutters and cleaners after they are laid.

Lastly, do not try to get a low price on a cable by reducing the thickness of the lead sheath, as the integrity of the lead sheath is fully as important as the quality of the insulation, and the life of the latter is wholly determined by the degree of perfection obtained in excluding moisture from it.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUESTION.—Can you inform me how are the capacities of switches figured?

ANSWER.—There is so little uniformity in the switches of different manufacturers that it is difficult to give you exact data on the above. For ordinary switches, where all parts of the metal are exposed to the air, a cross section of one square inch of metal for each one thousand amperes of current seems to be pretty near the standard, and a contact surface of at least one square inch for each one hundred amperes is also a general practice. Of course the forms of the contact surfaces, and the pressure which exists between them, are material factors in figuring the necessary area. It is important, where switches are carrying heavy currents, that some means of making a quick break be incorporated into the switch mechanism. This is done in various ways and you are no doubt familiar with the general design of such devices. It is of material importance to have the blades of the switch move easily and enter the jaws in a positive position without cutting or grinding of the metal. Switches which are flimsy in construction, and have not the necessary mechanical strength to enter the jaws in a fixed way, will soon give trouble through bad contact, and are, to say the least, sources of continual trouble. It is on this ground that the Underwriters do not favor the use of Baby knife switches, preferring in their stead a snap switch of good construction. Switches for use above 500 volts should, in many cases, be placed under oil. This insures constant lubrication of all moving parts, and limits the burning of the contacts, besides giving the switch a very much greater breaking capacity.

QUESTION No. 2.—What are current limiting devices, and how are they used?

ANSWER.—In many of the small towns in Canada and United States, current is soid to consumers on a flat rate basis, the contract price being made according to the number of lamps. It is a regrettable fact, but nevertheless true, that many consumers are animated by a strong desire to get more from an electric light company than they pay for, and various schemes are adopted to further this end. A consumer may use 32 or 50 candle power lamps when he has contracted for sixteen only, and he may also wire up additional lamps on his circuit without notifying the company of such fact. Where a meter rate is used, the company's revenue will be increased proportionately, but where flat rates are in vogue, the consumer continues to pay his fixed rate and is really obtaining more light than his contract calls for. Current limiting devices have therefore been developed for use in connection with such consumers, or in locations where the company may suspect that the practice is carried on. The devices usually consist of a solenoid operated switch which is so counterbalanced that the switch will remain closed until the current reaches a certain predetermined point. For instance, a consumer may contract for twenty 16 c. p. lamps, and the current limiting device will be set so as to open if the current exceeds 11 amperes. As soon as it opens, the magnetizing force of the solenoid is interrupted and it immediately closes again, reopening at once if the circuit takes 11 amperes or more. In this way, if the consumer is taking more current than his contract calls for, his lights will be turned on and off at a very rapid rate until he reduces the number of lamps burning to the amount specified. If one of the company's men should be watching the consumer's premises at this time, he will get immediate indication owing to the flickering of the lights that the consumer is using too much current, and in any event the consumer himself cannot get satisfactory light until he takes the extra lamps off the circuit. Devices for this work are not expensive, and are certainly very effective in combatting the evil.

QUESTION No. 3.—An electric brake was used in Pittsburg some years ago which was applied directly to the track. Can you give me any information as to the operation of this brake?

ANSWER.—The brake you refer to was very successful in bringing a heavily loaded car to an immediate stop, but its braking capacity was so great as to produce serious depreciation of the car and trucks, and it also had the additional disadvantage of decreasing the capacity of the car motors. Street railway motors, as you no doubt are aware, are rated on a temperature rise of sixty degrees centigrade in one hour, and their enormous capacity per unit per weight is due to the fact that for a great part of the time they are running idle. Any brake, therefore, which uses the motors as a source of current will cause the operating temperatures of such motors to increase. The brake used in Pittsburg consisted of a shoe suspended a short distance above the track by means of springs. These shoes were wound with wire, and when the coils were thrown across the motors the brake pulled down on to the track. This is the first braking action, and the second occurs due to the load which is thrown on the motors. As the car advanced, the shoes on the track naturally pulled backward, and this strain was taken up by the usual shoe brakes applied to the wheels of the car. As before stated, the brake was very effective in stopping the cars, but its disadvantages outweighed its good points.

ELECTRICAL EXHIBITION AT CHICAGO.

The second annual show of the Electrical Trades Exposition Company will be held at the Coilseum, Chicago, January 24th and 26th, and will, according to present indications, surpass last year's success. Managing Director H. E. Neis states that the space already sold is considerably greater than that disposed of for the 1906 Exhibition, a number of exhibitors having doubled their space.

It is probable that a by-law will be submitted to the ratepayers of North Toronto, Ont., in January, to raise $10,000 for an arc and incandescent lighting plant and a fire alarm system.

TELEGRAPH and TELEPHONE

FIRST GRAND TRUNK PACIFIC TELEGRAPH POLE.

The first pole of the Grand Trunk Pacific Telegraph Company was erected with appropriate ceremonies at Portage la Prairie, Manitoba, September 14th, near he spot where the first rail was laid.

The company is organized under Dominion charter with the right to use telegraph, telephone or wireless, is capitalized at $5,000,000, and being closely allied with the Grand Trunk System and the Grand Trunk Pacific Railway, will undoubtedly develop into a great system, extending from ocean to ocean.

GRAND TRUNK PACIFIC TELEGRAPHS—FIRST POLE ERECTED AT PORTAGE LA PRAIRIE, MAN., SEPTEMBER 14, 1906.

Mr. Chas. M. Hays is president, Mr. Frank M. Morse vice-president, Mr. Henry Phillips secretary, and Mr. A. Bruce Smith a director and general manager.

WIRELESS TELEGRAPHY.

In the course of an article by Herr A. Furst, which was published in a recent issue of the Berlin Tageblatt in reference to a visit paid to the wireless telegraph station at Nauen, which is not many miles distant from Berlin, it is stated that the station is able to communicate with safety over a distance of 1,550 miles, and the opinion is expressed that the time is not very remote when it will be possible to telegraph to New York. Specially interesting is the statement that the engineer in charge of the station on the occasion of the visit remarked that he would endeavor to ascertain whether the "brothers" at Poldhu were telegraphing at the time. Shortly afterwards the Morse instrument began to work, and the dots and dashes on the paper strip, it is said, indicated English words which, however, revealed no sense. Nevertheless, the author observes that it was ascertained that the telegrams were in cipher, and were being sent by the English admiralty to the cruiser Carmania at sea. When the Nauen station does not understand anything sent out by Poldhu, the former produces its wave measuring apparatus, and by this means ascertains in a very short time the wave length at which the English station is working. The Nauen receiving apparatus is set accordingly, and the secret is one no longer. It is understood, Herr Furst states, that the people of Poldhu act in a similar manner. The Nauen station is 325 feet high, and the proprietary company is credited with the intention of erecting a second tower which will be 975 feet high, or as high as the Eiffel tower.

RULES FOR TELEPHONING.

In rules regarding the use of the telephone enforced by Marshall Field & Company, the following notice is conspicuously displayed in every department of their big Chicago store: "The manner in which a person uses a telephone indicates his character to a great extent and makes either a good or bad impression, and this impression is reflected directly upon the establishment from which such a message comes. It is a pleasure to do business with a house which performs every detail in a clean-cut, satisfactory manner; but it leaves a sting to be answered abruptly or discourteously over the telephone. It is folly to lose one's temper because one does not get immediate connection. This is rarely if ever the fault of the telephone operators, who are nearly always courteous and prompt. When one is called to the telephone he should respond quickly, and the person calling should not be left to hold the wire too long—something decidedly irritating and often unnecessary. Let us throughout the whole house strive to excel in satisfactory telephoning. Important Note—You will be heard distinctly if you place your lips within an inch of the mouthpiece and talk naturally, as if the person were standing beside you."

COST OF TELEGRAMS.

The annual report of the Western Union Telegraph Company for the year ending June 30th, 1906, shows a substantial addition to gross revenue but a large increase in the expenses, resulting in a decrease in the net.

The almost stationary position of the gross earnings is shown by the following comparison of the gross per mile of wire operated:

Fiscal Year.	Miles of Wire.	Receipts.
1903	1,089,212	$29,167,686.80
1904	1,155,405	29,249,390.44
1905	1,184,557	29,033,635.04
1906	1,256,147	30,675,654.53

The reduction in earnings per mile is partly the result of the addition in mileage which has not developed as large an earning power as the old mileage, located in larger centres of population. It is also due in a large part to the inroads made by competition.

The number of messages and receipts and expenses per message compare as follows:

Fiscal Year.	Messages.	Aver. Tolls per Message.	Aver. Cost to Company of Message.
1903	69,790,866	31.4 cents	25.6 cents
1904	67,903,973	31.7 "	26.1 "
1905	67,477,320	31.6 "	27.3 "
1906	71,487,082	31.6 "	27.6 "

As the cost per message shown does not include the expenditures for maintenance and reconstruction, it will be seen that the increase has been in actual expenses of operation. Higher wages and competition are stated to be responsible.

A telephone system is being installed at Rosthern, Alta.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

New Wireless Telegraph Receiver.—At a recent meeting of the American Institute of Electrical Engineers, Dr. Lee De Forest described a new type of wireless telegraph receiver which he has named "audion," and which he believes offers great possibilities of advance in the wireless art. A feature of this receiver is what he calls its self-tuning properties. The device is, in brief, a peculiar type of incandescent lamp provided with one or more electrodes within the bulb. When the filament is brought to incandescence an electric current may be caused to pass between it and the electrode and through a suitable circuit without the bulb, and if a telephone be included in this circuit it is found that it gives a sound whenever the device is subjected to Hertzian waves. The device may be adjusted by varying potential in the circuit between the filament and electrode, and this adjustment seems to be practically independent of the natural period of oscillation of the aerial system; in fact, the device seems to depend for its action upon the total energy received by it during the entire period of vibration of the oscillating system, and not upon the maximum intensity of the first impulse. This feature would seem to be of considerable value, as one of the difficulties in wireless telegraphy is to concentrate upon the receiver sufficient energy to operate it.

New Italian Insulator.—A new Italian insulator designed by Signor Guido Semenza was shown at the Milan (Italy) exhibition. One of the troubles encountered in high-tension plants in Italy has been the breaking down of the insulators during heavy rains. To guard against this trouble it has been usual to make the upper petticoat with very large diameter to enable it to protect the lower part of the insulator. The conductor is carried on this head. This necessitated making the whole of this petticoat of the same insulating material which forms the chief part of the insulator, and it had to be made with just as much care as the lower petticoats. The recent tendency to increase the working pressures has made it necessary to increase correspondingly the diameter of the upper petticoats, which resulted in a great increase in cost. It was to get over this difficulty that Signor Semenza designed the insulator, which is described in the Electrical Review. In this insulator the wire is fastened below the upper petticoat. It is therefore unnecessary for this petticoat to be strong enough to resist perforation; it need only be watertight and sufficiently hard to resist mechanical shocks and rough usage in transportation. It is therefore made of a form of terra-cotta, which is neither so costly nor so breakable as porcelain or glass. Since the point of attachment of the wire in the Semenza type is somewhat lower than that in the old type, the stain moment of the wire is greatly reduced, which makes allowable a reduction in the thickness of the insulator and in the diameter and cost of the iron bolt; and since this upper petticoat or umbrella is not connected in any way with the pin, complications due to increased capacity are avoided. It is found possible to use a much lighter insulator of the Semenza type in order to secure the same breakdown voltage.

It is claimed that there is a saving of from thirty to forty per cent for an equally safe installation by using the Semenza insulator, with pressures from 35,000 to 50,000 volts. For higher voltages up to 80,000 or 90,000 it is thought that a saving of fifty per cent will be effected. One of the reason for the excellent performance of this insulator is said to be the fact that the wire is at no time in touch with the stream of water running over the surface of the effective petticoat of the insulator.

Protection of Transformers.—In these days of high-potential transmission of power the question of insulation is occupying the time and attention of a great many thoughtful and practical men. Economy is continually urging the use of higher voltages, and the effort of the inventor is to devise means of safely generating, transmitting and utilizing them. Even in the highest-class apparatus, however, there are breakdowns of insulation and the results are expensive, annoying and sometimes very dangerous. In many cases the trouble is not due to defective design or workmanship but to the fact that it is difficult thoroughly to inspect the condition of some of the apparatus while it is in use.

The transformer, especially in the larger sizes, is from necessity so designed that it is often both dangerous and difficult to inspect it thoroughly on account of the inaccessibility of the parts and the nature and proximity of the operating currents. Very often the insulation of the high-voltage coils depends partly on a surrounding liquid, as in the case of many oil transformers. If a leak occurs in the joints or fittings of the tank containing the transformer, or if much evaporation takes place, the liquid may become lower than the upper windings of the coils, and even if the insulation between the exposed parts is sufficient to stand the strain, the lack of the heat-conducting influence around them may cause an undue rise in temperature and seriously damage the apparatus.

John J. Frank, of Schenectady, N. Y., has been granted a patent covering a device which he claims will not only give warning of this dangerous condition but will protect the apparatus. He places electrodes or sparking points inside the tank at the lowest level to which the bath may fall without danger to the apparatus. He then connects these to a source of current which has not sufficient voltage to produce sparking through the oil, but which will cause sparks to pass between the electrodes if they are exposed to air. This sparking would occur, then, if the level of the liquid falls below the electrodes, and the attendant, being provided with means to observe any fluctuations that occur in the current proceeding from the

electrode-circuit source, is giving warning of the unsatisfactory condition which exists in the tank. Not stopping with this, however, the inventor plans his source of current in such a manner that the sparking not only will give the warning needed but actually tend to protect the apparatus.

For instance, the sparking points may be connected to one or more of the windings of the transformer. In this case, if the fluid level falls so that the sparking points are exposed the current normally passing through the transformer winding will be shunted through the electrode circuit, including the arc between the electrodes. This will protect the windings, and the attendant will receive warning of the conditions by observing the effects on the external circuit.

Different sets of electrodes in the same apparatus may be used in connection with any winding and the connection may be made in various ways so that all the windings are protected. In order to limit the current flow through the arc between the electrodes a resistance may be used in series with each protective circuit.

EXTENDED TERMINAL FUSE.

The advent of the Shawmut Extended Terminal Fuse, patented November 6, 1906, should be hailed as a great stock saver by the jobber. Heretofore it has been necessary for any enterprising jobber to keep on hand a supply of fuses manufactured by three or four companies.. This meant that a large amount of money and space was used up that could be much better devoted to other purposes.

With the new Shawmut Extended Terminal Fuse, the jobber can reduce his stock to one-third its former size and still be in a position to give perfect satisfaction. This extended terminal fuse fits any type "A" or screw clamp base on the market.

The extended terminal is scored and after the fuse is fitted to a base, either Noark, D. & W. or Chase-Shawmut, the projections may be removed with a pair of plyers without any trouble.

HYMENEAL.

A fashionable wedding took place in the James street Baptist church, Hamilton, Ont., on Thursday, November 29th, the contracting parties being Miss Mabel Greening, second daughter of Mr. and Mrs. S. O. Greening, and Mr. N. S. Braden, sales manager of the Canadian Westinghouse Company and only son of Dr. James Braden, of Indianapolis. The ceremony was performed by Rev. J. C. Sycamore, assisted by Rev. Dr. Lyle, in the presence of a large gathering of guests from the city and outside places. Miss Hattie Greening, sister of the bride, was maid of honor, and the bridesmaids were Miss Edna Greening, sister of the bride, Miss Gladys Zimmerman, of Hamilton, and Miss Agnes Ellis, of Hespeler. The groomsman was Mr. W. G. Cameron, of Cleveland, and Messrs. William Prince, Cleveland, H. D. Shute, Pittsburg, William Greening, Toronto, and H. M. Bostwick and Stuart MacDonald, of Hamilton, were the ushers. The gifts of the groom to the bridesmaids were gold enameled pins, and to the groomsman and ushers gold enameled pearl stick pins. The ornaments of the bride included a magnificent twin setting diamond ring, also the gift of the groom.

A reception was held at "Fonthill," the residence of the bride's parents, which was artistically decorated for the occasion. Gifts almost innumerable were received by the bride, including a sterling tea service from the Westinghouse staff at Montreal and a case of silver from the Pittsburg Westinghouse staff. Mr. and Mrs. Braden left in the evening for the South on an extended trip and on their return will reside at 134 Duke street, Hamilton. The ELECTRICAL NEWS joins with their many friends in extending congratulations.

THE LATE MR. L. TRUDEAU.

Mr. Ludger Trudeau, superintendent of the Montreal Street Railway system, died on Tuesday, December 11th, at his home, Fourth avenue, Maisonneuve. Mr. Trudeau had been afflicted with Bright's disease, and for six months had been unable to attend to his duties. He was 46 years of age and leaves a widow and four children.

Mr. Trudeau had been in the employ of the Montreal Street Railway for twenty-four years, having entered the service as a conductor in the days of the old horse cars. He was an efficient man and rose to higher positions, becoming an inspector when the electrical system was established. When Mr. Duncan McDonald, the present manager of the system, went to France to assume charge of the electrical systems centred at Paris, Mr. Trudeau accompanied him, and was placed in charge of the system of Bordeau. Afterwards Mr. Trudeau went to Alexandria, Egypt, and became manager of the trolley system there. After being three years in Alexandria he returned to Montreal. In January, 1904 he was appointed superintendent of the system, replacing Mr. Luke Robinson, who had resigned owing to ill health.

THE LATE MR. L. TRUDEAU, SUPERINTENDENT MONTREAL STREET RAILWAY.

POWER RATES AND FACTORS WHICH INFLUENCE THEM.

At the regular weekly meeting of the Engineers' Club of Toronto on December 6th, the subject for discussion was "Power Rates and Factors which Influence Them," which was introduced by Mr. R. G. Black. Mr. Black referred at some length to the different conditions and circumstances which influence the cost of electric power. He was followed by several other speakers, who severely condemned the report of the Hydro-Electric Power Commission as inaccurate and incomplete and calculated to mislead the public as to the actual price which will have to be paid for electric power. The Chairman of the Hydro-Electric Commission has since attempted to defend the report, and apparently a controversy has been started which cannot but be beneficial to the public, who are entitled to more definite information before being asked to support what seems to be a visionary proposition.

THE CARE OF BELTS

By C. J. Morrison.

One great item of expense in every machine shop receives, as a rule, very little attention, and that attention by an unskilled laborer. This item is belting. The expense comes not only from the outlay for belting and supplies, but also from the delays caused by failure. In many shops it is a common sight to see high-priced machinists standing idle waiting for a belt to be repaired. There is probably no belt repair room and no one who really knows how to care for a belt. This is an expensive mistake.

BELT ROOM.

In a shop of any considerable size, there should be a regular belt room, fitted up with a complete outfit for repairing belts. This room should be about 10 x 35 feet, centrally located, well lighted, and locked at all times so that the belting will not be stolen. The room should be provided with facilties for heating glue and a rack for storing the belting. The tools should consist of a 100-foot steel tape, a belt trimmer, a smoothing plane with a 1⅝-inch blade, pliers, clamps, punches, hammer, awl, three straight edges, a tank for belt dressing, a heavy letter press, and tools for making whatever kinds of lace are used. There are many kinds of laces, but it is not within the province of this article to say which is best, although tests and actual service have proved one kind to be far ahead of all the others.

Width : Thickness : Length :		BELT RECORD CARD		Shop : Machine : Position :
Requisition issued : Requisition filled :		Purchased from : Cost :		Scrapped : Scrap Value :
Max. Speed :				
Max. Power :		INTERRUPTIONS		REMARKS
Max. Tension :				
Splices :				
DATES	MAINTENANCE	DATES	CAUSE	
	Put on by			
	Tightened to lbs. tension			
	" "			
	" "			
	" "			

MAINTENANCE COST.

Belts should be maintained at a total cost, including labor, supplies and new belting, of between 14 and 25 per cent. a year of the inventoried value of the belting when new. In many shops the cost is over 100 per cent. The belt failures per month should not be more than three to every 100 belts. No main-drive belt should ever be allowed to fail, and no delay of over 10 minutes due to any failure should be tolerated. These results cannot be obtained by haphazard methods. In a shop running 800 or more belts there should be a regular foreman to keep the records and direct the work. This foreman can also take charge of the oiling and abrasive wheels. In a smaller shop the foreman would also be expected to work. No one should be allowed to draw any belting from the storehouse except the belt foreman. A record of every belt should be kept, such as is shown in the accompanying figure. All possible repairs should be made outside of working hours. The following simple rules cover about all there is in the care of belts.

CEMENT LPLICES.

In making the common splice, the first thing to be noted is to see that the pieces put together are about the same grade, width and thickness, and that the splices lie in the same direction as the same belt. Splices should be made of the length given in the table:

Width of Belt.	Length of Splice
1 in.	5 in.
2 in.	5 in.
3 in.	6 in.
4 in.	6 in.
5 in.	7 in.
6 in.	8 in.
7 in.	8 in.
8 in.	9 in.
9 in. to 18 in.	Same length as width.
Over 18 in.	18 in.

They should be worked down to a perfectly smooth even surface, square with the edge of the belt both at the point and back.

Care should be taken to see that the splice is no thicker than the rest of the belt. If the splice is thicker the belt will not run even. Square both ends of the splice from the same edge of the belt. Work on a perfectly smooth flat surface and, after dressing the ends for the splice, place them on a board 1 inch longea and 0.5 inch wider than the splice. Place the edges from which the splices are squared in a perfectly straight line. Take the belt to a board just back of the splice.

Open the splice and spread on hot glue, place another board on top of the splice and clamp tightly with hand clamps or in a press, such as an old letter press. If a press is used, 10 minutes is long enough to keep pressure on the belt, but if hand clamps are used they must be left on for 3 or 4 hours. In either case, the belt should not be put under tension for at least 5 hours after glueing. Paper placed between the boards and the belt will prevent the belt from becoming glued to the boards.

Greasy belts should be cleaned with gasoline before attempting to cement them. Any grease in belts or glue is likely to cause the splice to fail. No rivets, wire, pegs or any other fastenings aside from cement should be used in splicing belts. Ordinary furniture or patternmaker's glue is satisfactory for belting.

TENSION AND THICKNESS OF BELTS.

Belts should have a tension when at rest of about 100 pounds per inch of width of good double belting. If not practicable to measure the tension on the belt, make the cut length 1 inch per 100 feet less than the

tape-measured length over the pulleys. A steel tape should be used. Great care should be used to prevent the running of too tight belts and consequent burning of bearings.

Double belts should not be run on pulleys less than 6 inches in diameter, nor triple belts on pulleys less than 20 inches in diameter. Belts should sag onto pulleys and not away from them. Very short drives (belts under 20 feet long) should be avoided. Whenever possible, run up-and-down belts on a slant so that the belt will sag onto the pulleys.

ENDLESS BELTS.

All machines furnished with any means of taking up the stretch should have endless belts. Large overhead drive belts, over 6 inches wide, should be made endless as soon as the stretch is taken out. It is not advisable to make new belts endless at installation on account of the stretching. Wood-working machines having belts which do not require too frequent tightening will run better with endless than with laced belts. Side and bottom head belts on planers, matchers, etc., should be run endless.

CLEANING AND OILING.

Belts which have become too greasy and dirty should be cleaned with gasoline, then scraped, and wiped with waste. In dry, dusty places it is well to brush them occasionally with a broom or stiff brush.

No rosin or belt dope should be used except fish oil and tallow mixed in equal parts. Apply hot with a brush when the belt is running or dip the belt in the dope tank, then dry and wipe off any grease which may have hardened on the belt. If applied while running, care should be taken not to get too much on the belt, or it will cause it to slip.

No mineral oil should be allowed to come in contact with belts. New belts should be treated with fish oil and tallow before using, and any belt which becomes dry, hard, and glossy in service should have an application of the dressing. This is especially true of belts in blacksmith shops. The oil will check to some extent the evil effects of the smoke, sulphur gases and dirt, and the life of the belt will thereby be lengthened.

OPERATION OF BELTS.

In the successful operation of belts it is essential that the pulleys and shafting be properly lined and in good repair. It is bad practice to throw a pulley out of line to favor a bad belt. Belts should be run with the hair side to the face of the pulleys. Run belts so that the outside point of splice trails. This will avoid opening the splices by the action of the air. Belts should never be run twisted or cross-stepped on cones.

Keep pulleys clean and avoid having mineral oil or grease in contact with the belts. If hard grease or dirt is allowed to pile up in corners of cones so as to form a fillet, the belt will be very likely to climb, turn over or twist. In turning faces of cones, a clearance should be cut in the corners.

A belt should never be dampened in order to open a splice. An awl should be used, gradually scratching or ripping the splice apart.—American Machinist.

The Canadian General Electric Company are furnishing two engine-driven railway generators for the Montreal Street Railway. They have also secured the order for 80 additional railway motors.

SAFETY SYSTEM FOR HIGH-TENSION TRANSMISSION LINES.

With the high-potential systems of to-day, where the power output is large, it sometimes happens that the main switches are unable to stand the strain of opening under excessive overload. This fact points to heavy and therefore more costly switches, or else a method of opening the circuit without throwing the full strain on the switch.

A system which, it is asserted, will accomplish this

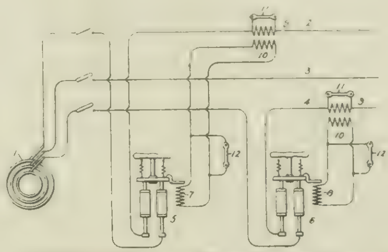

Fig. 1. Safety System for High-Tension Three-Phase Transmission Lines.

purpose and admit the use of even smaller and less expensive switches has been patented by John D. Hilliard, Jr., of Glens Falls, N. Y. Mr. Hilliard uses a series transformer connected in the line, two such transformers being used for a two-phase or three-phase circuit. Both the primary and secondary of this transformer are shunted by fuses or other automatic circuit-breaking devices; and across the secondary terminals is connected a trip coil to operate the automatic line switch.

In the accompanying drawings Fig. 1 is a diagram showing the invention applied to a three-phase alternating current circuit, and Fig. 2 shows it applied to a direct-current circuit.

In Fig. 1 (1) represents a three-phase generator supplying current to the conductors (2) (3) (4), two of which are provided with automatic circuit-breakers (5) (6), which are released by the energizing of the trip-coils (7) (8). In each of two legs of the line is the primary (9) of a series transformer. The secondary winding (10) of each transformer is in series with one of the trip-coils of the switch. In shunt to each primary winding is a fuse (11) of a wide-opening or arc-extinguishing type. The secondary windings are each short-circuited by a fuse (12).

Under normal conditions of the service the drop across each primary winding is small, owing to the

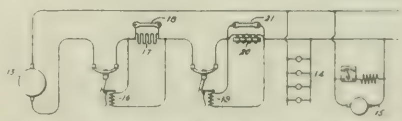

Fig. 2. Safety System for High-Tension Direct Current or Single-Phase Transmission.

mutual induction of the primary and the short-circuited secondary. The current in the secondary does not affect the trip-coil, because this coil is shunted by the fuse (12); but when an excessive overload is applied to the line the increased current through the fuse (11) causes it to blow. The entire current is thereby thrown upon the primary, and the secondary current consequently increases and blows the fuse (12). This causes the secondary current to energize the trip coil,

realease the switch, and open the line; but the instant the fuse (12) blows the secondary is practically opened by reason of the great resistance and self-induction of the trip-coil, which is wound to give this effect. The reactance of the primary winding (9) is therefore greatly increased, causing a large drop across the terminals of that coil, and this affords a protection for the line switch against the liability of blowing up, so that smaller and less expensive switches can be used than would be safe otherwise.

In Fig. 2 a direct-current generator (13) is shown carrying a non-inducive load (14) and an inductive load (15). Two automatic circuit-breakers are shown in circuit with the generator, one of which has its overload-coil (16) shunted by a non-inductive resistance (17) and a fuse (18), arranged in multiple, the overload-coil (19) of the other circuit-breaker being similarly shunted by an inductive resistance (20) in multipe with a fuse (21). In the case of an overload the fuses (18) and (21) will blow and the resistances serve not only to protect the circuit-breakers from an excessive potential, but to force sufficient current through the coils (16) and (19) to trip the circuit-breakers.

The circuits and apparatus in Fig. 2 can remain the same if generator is changed to a single-phase alternator.—Western Electrician.

GOVERNMENT PRICES FOR ELECTRIC POWER.

To twenty-one of the municipalities which have made application for a supply of electrical energy, the Hydro-Electric Power Commission have furnished estimates of the prices at which their request can be complied with. The information supplied is contained in the list appended. First are given the minimum and maximum costs at which the full amount applied for by the municipality can be supplied by the Commission. These will vary between the limits mentioned according to the terms on which the Commission obtains its supply of electricity for transmission. Slightly higher rates are also quoted for quantities less than those specified in the applications received. In each instance the price is for twenty-four hour power stepped down and ready for distribution to consumers.

MINIMUM AND MAXIMUM PRICES QUOTED BY THE HYDRO-ELECTRIC POWER COMMISSION FOR ELECTRIC POWER.

	H. P. Consumption	Price per H. P. Minimum	Price per H. P. Maximum	H. P. Consumption.	Price per H. P. Minimum.	Price per H. P. Maximum.
1. Beriin	3,000	$17.85	$20 83	3,000— 1,500	$18.00	$23 50
2. Waterloo	900	19.02	22.01	900— 600	19 00	24.50
3. Guelph	3,000	18.01	20 79	3,000— 1,500	18.00	24.00
4. Hespeler	750	19.02	21.81	750— 500	19.00	24.50
5. Preston	800	19.00	22.00	800— 600	19.50	23.50
6. Galt	2,500	17.37	20.07	2,500— 1,500	17.50	22.00
7. Paris	1,000	18.16	20.90	1,000— 500	18.50	24.00
8. S. Dumfries	3,000	16.63	19 37	3,000— 1,000	17.00	21.50
9. St. Thomas	1,500	21.10	23.76	1,500— 1,000	21.50	26.50
10. London	10,000	17.49	20.28	10,000— 5,000	17.50	22.50
11. Tillsonburg	1,000	21.00	23.79	1,000— 500	21.00	28 00
12. Ingersoll	1,350	19 02	21.79	1,350— 900	19.00	23.00
13. St. Mary's	2,000	19.85	22.52	2,000— 500	20.00	29.50
14. Stratford	5,000	17.84	20.49	5,000— 1,500	18.00	24.50
15. Woodstock	1,200	18 95	21.73	1,200— 900	19.00	23.00
16. Brantford	3,000	16.57	19.30	3,000— 1,500	17.00	21.50
17. Brantford Township	300	16.57	19.30	300— 200	17.00	21.50
18. Hamilton	15,000	13.97	16.25	15,000— 8,000	14.00	17.50
19 Dundas	3,000	15.67	18.25	3,000— 2,000	16.00	19.00
20. Toronto Junction	10,000	14.56	16.98	10,000— 5,000	15.00	18.50
21. Toronto	30,000	14.15	16.61	30,000—15,000	15.00	17.75

NOTE—Brantford Township not included in above estimate, but quoted at Brantford rates, at Brantford sub-station.

SIXTY-SIX THOUSAND VOLT TRANSMISSION SYSTEM.

To the Grand Rapids-Muskegon Power Company, of Grand Rapids, Mich., belongs the credit of having successfully transmitted electric power at 66,000 volts. The plant has been in operation at that voltage since April 1, 1906, and for some time recently the voltage has actually been 69,000. The only material interruption during the six months of service was due to lightning, which split up a couple of insulators. The insulators used are of reasonable size and without any extraordinary precautions beyond what are usual in sound high voltage construction, being Locke insulators 14 inches in diameter over all and 18 in. high. Wooden pins are used on straight line work and iron pins on the corners. These pins are 18 in. over all and 2 in. in diameter under the shoulder. The same dimension of pin is used for both wood and iron. The transmission line conductors are No. 2 solid copper wire. Poles are from 45 to 60 feet long, none less than 45 feet being used. They are of Michigan and Idaho cedar and Southern cypress. Forty poles are placed per mile.

The grounds for the grounded wire are made by burying a coil of copper wire under every fifth pole. Static interrupters, choke coils and Westinghouse lightning arresters are placed at the power and substations. There are two 15,000 k.w. direct connected three-phase, revolving field, Westinghouse, 6,000 volt, 30 cycle generators with exciters on the same shaft. Each of these generators is connected to two pairs of Leffel horizontal shaft turbines running 225 r.p.m. The turbines are 45 in. in diameter and are of the center discharge type. Lombard water wheel governors are used, with Tirrill voltage regulators on the generators. There is one bank of three 1,200 k.w. transformers in this station, the excess capacity being provided so that in emergencies the output of the station may be delivered through two transformers. Oil switches are provided in both the 6,600 volt primary and 66,000 volt secondary circuits. The 66,000 volt coils are connected delta.

The company have also planned a transmission line on steel towers direct from Croton dam to Grand Rapids. This line, we are told by the Electrical World, will be of at least 66,000 volts and possibly may be operated at 100,000 volts.

MONTREAL

Branch Office of THE CANADIAN ELECTRICAL NEWS.
Room B34 Board of Trade Building

DECEMBER 7, 1906.

Mr. H. B. Kirkland, the genial sales manager for the American Circular Loom Company, severed his connection with that firm during October.

Whatever the differences may be between the Hamilton street Railway Company and their employees one fact remains, and we have realized it already in Montreal, that the public have some say in the matter and should not be forced to walk merely because the Company and their employees have differences. If the Company can run cars surely a "neutral" ought to be able to ride without fear of a stone coming through the window. Of course the Union will disavow such tactics (they always do) but it is strange how persistently unlawful acts follow such strikes and the Union are morally responsible for them.

We are informnd that Messrs. Henry Birks & Sons, the noted jewellers, have decided to equip their altered and enlarged premises with Nernst lamps, finding the light from them the most suitable for exhibiting their precious stones. This will be the first installation of any note of Nernst lamps in Montreal.

Since the first of September contractors in Montreal have had an unprecedented rush, in fact in Montreal with its varying seasons it is either a feast or a famine, and a considerable slackening off is looked for after New Year's.

Electrical supply dealers report business brisk and also complain of the delay in securing shipments from the United States either in complete manufactured articles or in raw material for use in their own factories here. As for English shipments, the bulk of the dealers are totally disgusted.

Failing to pass a motion in favor of raising the tax on real estate, the City Council of Montreal are now figuring how they can squeeze something out of the Bell Telephone, Street Railway and M. L. H. & P. Company. At present they get a goodly sum from the Montreal Street Railway, but like Oliver Twist, want more.

Again winter is upon us with its snow, and the patronage system existing in the Montreal City Hall still retains the small one-horse box sleighs for removing snow in spite of the fact that the Montreal Street Railway with approved appliances could remove the snow from such streets (at any rate as carry their tracks) in infinitely less time and at a less cost, but it was ever thus with civic affairs in Montreal.

It is rumoured that the Canadian Pacific Railway will adopt electrically operated signals on their lines from Montreal to Vaudreuil, of the Hall or somewhat similar type. At present Hall signals extend from their Windsor Depot to Montreal Junction: the extension to this system will be about 20 miles more.

A unique telegraph equipment may be seen at the C. P. R., viz., the Phantoplex, invented by Mr. F. W. Jones, the Electrical Engineer of the Postal Telegraph Cable Company. We understand it is at present operating between Montreal and North Bay. The system consists of using an induced alternating current, jumping the way stations by means of condensers and thus using existing lines without interfering with the ordinary Morse instruments. The Montreal Electric Company are looking after Mr. Jones' interests.

The old Beauharnois Canal which is now out of use is being diligently sought for by various interests to use as water power for the generation of electricity. The City of Montreal themselves are making inquiry at Ottawa in this regard.

The Magnetite lamps and equipment for the Westmount street lighting installation are on hand, and the municipal folks have already got their arc lines strung and hangers up to take over the contract which expires with the Montreal Light, Heat & Power Company this month. It is expected that Magnetite lamps will probably be burning about the 16th, and naturally there is a good deal of interest, as they will be the first of these lamps to be seen in this vicinity, if not in Canada.

The Municipality of Notre Dame de Grace have lately completed a water system. The pumping is done by motor, the current for the same being supplied by the Westmount municipal electric light plant.

Mr. E. E. Cary paid us a visit from New York lately and called upon all his old Montreal friends.

Mr. C. W. Bongard, of Toronto, has recently been in Montreal closing up some contracts.

The Terminal Railway of Montreal is now practically a thing of the past, having been absorbed by the Montreal Street Railway system. The roadbed will now be considerably overhauled and the rolling stock improved.

The Montreal Street Railway have made repeated demands on the city for the use of more streets, and the demand is fair and just. True, there are reasonable objections in tearing up an asphalted thoroughfare like Dorchester street, but it would take very little money for the city to make St. Luke street a thoroughfare. This parallels one of the main arteries, viz., St. Catharine street only a block's distance apart, and by joining into its natural continuations, Burnside and Ontario streets (the latter already laid with tracks), would make a straight run from extreme east to west.

The City Council of Montreal are greatly exercised over the question of the gas and electric franchise to be extended for some 30 years. The City Council are anxious to obtain money from percentages in this way to be u ed ostensibly for street repairs. Whilst the gas offer is not at all unreasonable, the electric lighting one is such than when the term expires we will be receiving almost as much discount as the Lachine Rapids Company gave before the confederation of companies here, and the Lachine Rapids Company paid a dividend too.

We understand that considerable friction is occurring at present between contractors and the inspection staff of the Montreal Light, Heat & Power Company over some of their decisions not called for under National Board rules. One item more particularly is the request for porcelain sockets on bathroom fixtures. From one point of view several excellently designed brackets have their appearance ruined by the use of such sockets. Further, they are not so strongly put together, and finally it would be just as reasonable to request that the bracket itself be made of porcelain tubing. As this is a life protection, not fire, it seems the duty of the company to ground their secondaries, and such requests will be unnecessary.

Whatever kicks the public may have at the Montreal Light, Heat & Power Company (and this is only a natural and usual result where any company has a monopoly), it cannot be gainsaid that the young men in charge of the various departments are efficient and courteous, in fact the official staff in this direction is second to none on the continent, and have been culled with care from the various staffs which were amalgamated at the time of the inception of the Montreal Light, Heat & Power Company a few years ago.

CROCKER WHEELER FORM I-F VARIABLE SPEED MOTORS.

Nearly all modern factory equipments require variable speed drive for machine tools. To meet this requirement in factories where the conditions do not warrant the installation of a multiple

voltage speed system, the Crocker-Wheeler Company have designed and are prepared to furnish a field weakening motor suitable for operating on a two wire direct current system and giving speed ranges up to 3 : 1. This line is known as Form I-F, illustrated herewith.

The Packard Electric Company, Limited, look after the interests of the Crocker-Wheeler Company in Canada, and Bulletin No. 67 describing these motors can be secured by addressing their head office at St. Catharines or their Montreal or Winnipeg offices.

SCHOOL OF SCIENCE DINNER.

The eighteenth annual dinner of the Engineering Society of the School of Practical Science, Toronto, was held at the Rossin House Friday evening, December 7th. About 400 persons were present. The tables were beautifully decorated and the banneret menu was a clever invention. The presiding officer was Mr. K. A. MacKenzie, President of the Engineering Society, while at the guest table sat President Hutton, of the University ; Hon. W. J. Hanna, provincial secretary ; H. Cockshutt, president Canadian Manufacturers' Association ; J. W. Flavelle ; Principal Galbraith; Dr. Ellis; Rev. Bruce MacDonald ; Edmund Burke, president Ontario Association of Architects ; C. H. Rust, city engineer ; Prof. Steward ; Prof. C. H. C. Wright; Prof. Mickle and Prof. T. R. Rosebrugh.

The toast list and respondents were as follows : "The King" by singing the National Anthem;" "Canada and the Empire," by Mr. Cockshutt ; "The Legislature," by Hon. Mr. Hanna ; "The University," by President Hutton and Rev. Bruce MacDonald ; "The Faculty of Applied Science," by Professor Galbraith; "Canadian Industries," by Mr. J. W. Flavelle, and "The Profession," by Messrs. C. H. Rust, M. Haney and E. Burke.

AUTOMATIC TRANSPORTATION SYSTEM.

The Automatic Transportation Company have an exhibition at 11 Colborne Street, Toronto, of an automatic transportation system invented W. C. Carr, of Buffalo, N.Y. It is practically an electric railway designed to automatically deliver mail, packages of merchandise, etc., to farm houses, stations or villages in rural districts. The carriers deposit while en route mail or packages at any or all stations on the line and at the same time collect mail or merchandise and return with it immediately to the starting point or central station. The track is elevated and the cars are controlled from one central point. It is claimed that one man can operate at least twelve rural lines. In connection with the automatic transportation line, telephones may be installed by any person on the line at the rate of 25c. a month. A Canadian company has been formed, the interests of which are in the hands of Mr. Bickerstaff.

ELECTRIC TRACTION ON THE COAST.

A definite step towards the construction of the proposed electric tramline between Chilliwack, B.C., and New Westminster was taken on November 29th, when Mr. R. H. Sperling, general manager of the British Columbia Electric Railway Company, and Mr. F. R. Glover, also of the B. C. Electric Railway Company, started out on a preliminary survey of the route to be followed. The line will probably follow as nearly as possible along the banks of the Fraser river.

While not definitely announced, it is expected that construction work on the new electric line will be commenced before the close of this year, and that the line will be in operation in about two years. The new interurban line will connect at New Westminster with the interurban line between that city and Vancouver.

The increased demand for rolling stock, which the continuous extension of the British Columbia Electric Railway Company's system necessitates, is requiring the doubling of the present capacity of the company's car shops at New Westminster. The company at present operate street railway systems in Vancouver, New Westminster and Steveston on the mainland, with interurban lines between Vancouver and each of the other places, also the street systems in Victoria, on Vancouver Island, which includes a line to Esquimalt, B. C., and all the new rolling stock for the past few years has been turned out from their shops at New Westminster. Work on the framework of the new cars for the Chilliwack line will be started shortly after New Years.

POWER PLANT EXTENSIONS.

The British Columbia Electric Railway Company recently turned on the water on a new unit at their Lake Buntzen power house, adding 3,000 h.p. to their former capacity. They expect soon to be calling for tenders for a new 5,000 k. w. generator for this power house, also new water wheels and the enlargement of their transforming equipment. The power house itself will require to be extended to accommodate the additional machinery. The need of this has been brought about by the increased demand for electricity as a result of the rapid growth of Vancouver, and the necessary extension of their street railway system, which includes complete railway facilities in the town of North Vancouver, across Burrard Inlet. The regular passenger traffic in North Vancouver was commenced a couple of months ago by a service on Lonsdale avenue, the main thoroughfare, and is being extended as needed.

The British Columbia Electric Railway Company are now running high tension wires to Ladner, B.C., for the supply of light and power to that town. At the crossing of the Fraser river there will be three 2,000 foot spans over the center of the river, the lines being placed on towers 320 feet high. In addition to that there will be one-third of a mile of pole line, the poles being set in dolphins. It is expected that current will be supplied to the town early next year.

TRADE ANNOUNCEMENT.

It has recently been called to the attention of the Chase-Shawmut Company that the claim is made by some that they are using in their enclosed fuses tubing made of asphaltum paper rather than of fibre as advertised by them. The Chase-Shawmut Company have recently sent samples of their tubing to an analytical chemist in Boston, who, after exhaustive tests on these samples and of fuses of this company's manufacture, bought in the open market, reports that the tubing used is vulcanized fibre of good quality.

The Chase-Shawmut Company will be glad to furnish copies of this report to anyone who is interested.

The Bell Telephone Company have contracted for 83,000 poles for delivery next year for the extension of telephone lines in Canada. This represents 2,500 miles of construction. The rural telephone service of the province of Manitoba will be doubled in extent. There are some 2,000 farmers connected at present.

Welland, Ont., Town Council have given the contract for street lighting to the Stark Electric System, Limited, of Toronto. The contract is for 40 arc lights of 2,000 c.p., and the price is $40 per light per year, all public buildings belonging to the corporation to be lighted free. The rate for private lighting is to be 8 cents per kilowatt, with 25 per cent. discount if paid by the 15th of each month.

SUCCESSFUL DRAFTSMANSHIP.

How often in the past have you been thinking and wishing to be more of a drafstman, in fact, wishing to be successful and first-class at this work? How often have you looked at plans and kept looking for a long time trying to make out certain lines? Have you not often felt considerably embarassed simply because you knew so little about plans, or you were unable to make even the simplest sketch or a correct, business-like looking drawing?

As your personal duty to yourself, your future and to the credit of your profession, you should by all means know all about drawing and be able to make first-class plans, details and designs.

Mr. Fred E. Dobe, M.E., and chief draftsman of the Engineers' Equipment Company, 97 Washington street, Chicago, has for a long time been making a practice of giving personal and individual instructions in complete architectural as well as mechanical drawing and designing, and is prepared to accept a few more students old or young. His instructions are given by mail, but must not be compared with the ordinary correspondence school instructions, as all the work is laid out personally by himself and prepared especially for individual requirements. With this method he is able to satisfy and educate any experienced or absolutely unexperienced man, who is willing to better himself.

FRED E. DOBE, M. E.

He furnishes no diplomas, but lets your work do the talking and guarantees by contract to qualify you in a few months' instruction to be able to hold a first-class draftsman position and instruct you until you are competent. His book, "Successful Draftsmanship," size 6x9, is sent free with full particulars for ten cents to cover cost of mailing.

PERSONAL.

Mr. Reid, late city electrician of Moose Jaw, Sask., has been engaged as superintendent of the new municipal pant at Kenora, Ont.

Mr. George Black, who has been manager of the Great Nothwestern Telegraph Company at Hamilton, Ont, for many years, has retired.

Mr. S. W. Smith, of Montreal, has joined the sales staff of the Packard Electric Company, Limited, and will cover the district of Ontario west of Kingston.

Mr. K. L. Aitken, consulting electrical engineer, Toronto, has removed to 1003 Traders' Bank Building, where he has increased accommodation for his growing business.

Mr. S. Walter Mower, general manager of the Southwestern Traction Company, London, Ont., has been elected Secretary of the American Street and Interurban Railway Engineering Association.

Mr. Louis W. Pratt, who has been connected with the Brantford Electric & Operating Campany, Brantford, for several years, has tendered his resignation in order to be become associated with the Federal Electric Construction Company, Limited, who have recently moved their head-quarters to the Stair Building, Toronto.

Mr. G. P. Cole, a graduate of McGill University, Montreal, has been appointed by Allis-Chalmers-Bullock, Limited, of Montreal, to superintend the designing and construction of electrical transformers. He entered McGill University in 1897 taking, first, arts, and later electrical engineering, graduating as B.Sc. in 1903. Last spring he obtained the higher degree of M.Sc. After leaving college he entered the employ of the Wagner Electric Manufacturing Company, St. Louis, where he became assistant chief engineer.

Mr. J. W. Baker, manager of the Canadian Pacific Telegraphs at Winnipeg, at the request of a large number of ratepayers, has consented to allow his name to be placed before the electors at the coming civic elections as a candidate for the Board of Control. Mr. Baker has resided in Winnipeg for the past sixteen years, and has followed civic affairs very closely.

Mr. James Costello, Ottawa, an electrician in the employ of Ahearn & Soper, Ottawa, was attending to some work at Welland, when he received a bullet in the mouth. The bullet evidently came from a revolver in the hands of some careless person, and there appears to be no doubt that the shooting was accidental. Mr. Costello was taken to the Toronto General Hospital.

The publishers of the CANADIAN ELECTRICAL NEWS extend their sympathy to Mr. H.E. Terry, chief engineer at the Terauley street station of the Toronto Electric Light Company, in the loss he has suffered by the death of his wife under most distressing circumstances. Mrs. Terry had entered an elevator in one of the large departmental stores for the purpose of ascending to another floor, when in an almost unaccountable manner she fell down the shaft and was killed instantly. The elevator proper had no door and it is supposed that her clothes were caught as the door of the enclosure was closed. She was 45 years of age and leaves a family of four, two boys and two girls.

SPARKS.

The St. John Railway Company, St. John, N. B., are building a large car stable on Union street.

The Canadian General Electric Company are installing an electric plant at Dorchester, N. B., for street and commercial lighting.

Mr. A. R. Knight and Mr. W. J. Wyles have formed a partnership to engage in the electrical contracting business at Woodstock, Ont.

The corporation of Notre Dame de Grace, Que., has made an arrangement for street lighting with the Town of Westmount, which has a municipal plant. The contract price is $35 a lamp for 100 incandescent lamps.

Gravenhurst and Bracebridge made application to the Hydro-Electric Power Commission for the power rights of South Falls on Muskoka river, and it is understood that the Commission will recommend to the Government that the power be developed for the joint benefit of the two municipalities.

Messrs. Walter Piggott, John Piggott, W. E. McKeough, W. R. Phillimore and W. C. Crawford have purchased the American interests in the Windsor, Essex and Lake Shore Railway Company and will henceforth assume all control of the road. The power house at Kingsville is now almost completed, and the line will be finished as far as Leamington in a very short time. It is expected that cars will be running between these two points by the first of May. The company intend proceeding with the line between Chatham and Leamington.

During the past season the Montreal Street Railway Company has renewed no less than twenty miles of track, and when Craig street, from Bleury street to its eastern limit, together with Amherst and Ontario, is permanently laid, the entire system will be in excellent condition. Speaking of the men employed on this great system, Mr. W. G. Ross, general manager, stated that there were now 1,800 conductors and motormen, and 2,300 employees all told. There are at least 100 men in the company's service averaging 60 years of age, and there are three conductors, Craig, Mason and Lafferty, who have been in the employ of the Montreal Street Railway Company from thirty to thirty-five years.

The Board of Trade of Minnedosa, Man., is at present concentrating its efforts on the organization of the Minnedosa Power Company, for the purpose of developing available water power in the vicinity. The Minnedosa Power Company was formed some few years ago, but owing to insufficiency of capital the charter obtained was never utilized until now, when it is the intention to float the company as speedily as possible. With this object in view the Board of Trade has issued a prospectus inviting applications for stock. Col. H. N. Ruttan, city engineer of Winnipeg, has reported as to the available sites.

PUBLICATIONS.

We are indebted to the Electric Controller & Supply Company, of Cleveland, Ohio, for one of their latest souvenirs.

The Century Electric Company, of St. Louis, Mo., describe in their November bulletin the "Century" single phase motors, for which they report a large demand. These motors are carried by the Jones & Moore Electric Company of Toronto.

A very complete catalogue of "Franklin" air compressors has been published by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, and 95 Liberty street, New York. It contains 118 pages.

The R. E. T. Pringle Company, Montreal, are distributing a catalogue of P. & S. electrical specialties as manufactured by Pass & Seymour, Inc., Solvay, New York. Among the lines included are plugs, porcelain switch bases, bushings, cleats, cut-outs, sockets, insulators, receptacles, rosettes, tubes, etc.

The Macallen Company, of Boston, are well known as manufacturers of electric railway material, insultating joints and electrical specialties. They recently issued a price list and catalog of these goods, a copy of which may be obtained upon application to their Canadian agents, Messrs. J. A. Dawson & Company, 291 Craig street west, Montreal.

The Telephonic Age of Canada, a journal devoted to the furtherance of the popular telephone movement in Canada, made its appearance last month, the publishers being the Biggar-Wilson Company, of Toronto. The object of the paper is stated to be, in short, to get into Canadian homes the half million or more phones for which there is a present demand. The first number consists of thirty-six pages, with an attractive cover, and is typographically a credit to the publishers.

"Alternating Current Motors," by A. S. McAllister, Ph. D., has been published by the McGraw Publishing Company, New York. The author deals directly with the electromagnetic phenomena of alternating current motors in a simple manner, and wherever mathematical equations are employed, the assumption upon which they are based is definitely stated. Moreover, the significance of each transformation is carefully explained. Much attention is given to graphical diagrams and to examination of the facts upon which they are based. The book, which contains 280 pages, is thoroughly illustrated, and sells for $3.

Longmans, Green & Company, 39 Paternoster Row, London, E. C., have just brought out a book which should have a large sale. It is entitled "Producer Gas," the authors being J. Emerson Dowson and A. T. Larter. Professor Dowson has devoted 30 odd years to the subject of producer gas and its applications, and in 1881 he exhibited his apparatus at the Paris Electrical Exhibition. The first three chapters of the book are devoted to a consideration of the formation of producer gas from a strictly theoretical point of view. Then follow chapters devoted to furnace work, engine work, suction plant, comparision of gas and steam power, gas from bituminous coal for engine work, calorific power of solid and gaseous fuels, etc. Retail price, 10s. 6d.

Whittaker & Company, London and New York, have just issued a useful book entitled "Continuous Current Dynamo Design." It is devoted largely to elementary principles and is intended, in the first instance, as an aid to students. The author is H. M. Hobart, M.I.E.E., Mem. A.I.E.E., who calls special attention to the introduction of 18 complete designs in calculated form. For convenience of calculation and study of these designs, tables have been introduced in each chapter giving just sufficient data of the 18 machines to enable the student to calculate the parts of the design with which the chapter has been dealing. Thus when this is done he will have arrived at the complete calculation for these 18 designs. The book contains 106 illustrations and may be obtained from the MacMillan Company of Canada, Limited, 27 Richmond street west, Toronto; retail price $2.

TRADE NOTES.

Jenkins Bros., of New York, have ordered a 150 horse power engine from the Robb Engineering Company for the new factory they are building in Montreal.

The Tacoma Steel Company recently purchased from the Vancouver office of Allis-Chalmers-Bullock a large duplex steam compound air compressor, complete with inter-cooler, together with a number of 3¼ inch Ingersoll lock drills. This apparatus is all for installation in the addition to the Marble Bay Mines on Tuxedo Island, B. C.

The Gilson Manufacturing Company, of Port Washington, Wis., have found it necessary, owing to the increase in their business, to establish a Canadian factory. This is now being built at Guelph, Ont., and will be ready for operations at an early date. This company manufacture a complete line of air-cooled, water-cooled and oil-cooled gasoline engines in sizes from 1 h. p. to 15 h. p. and adapted for all power purposes.

The Hamilton Engine Packing Company, of Hamilton, Ont., have lately opened up an office and warerooms in Vancouver, B. C., for the purpose of more expediently looking after their western business. The office is located at 842 Pender street and is in charge of Mr. A.W. Clappison, formerly of the Toronto office. In the Vancouver warerooms they are carrying a full line of engine packing, pipe and boiler covering and engineers and mill supplies.

Allis-Chalmers-Bullock, Limited, through their Vancouver office, have secured the contract for the supply and installation of the complete lighting equipment in the new Empress (C.P.R.) Hotel at Victoria, B. C. The equipment will consist of three 75 k. w., d. c., engine type generators direct connected to three 13 x 14 Robb-Armstrong engines, also complete switch-board equipment consisting of three generator panels, one power feeder panel, and three lighting feeder panels, all of blue Vermont marble. The fact that this order was received under keen competition speaks very highly for the excellent quality of the Allis-Chalmers-Bullock product.

The business heretofore carried on by Mr. C. E. Shedrick at Sherbrooke, Que., has been formed into an incorporated company, under the the name of Shedrick, Rigby Company, Limited, with headquarters at 157 Craig street west, Montreal. Mr. Shedrick will continue to be intentified with the business, which will be conducted on a more extensive scale than heretofore and will embrace the following lines: Electrical measuring instruments; electrical heating and cooking apparatus; Shedrick's electric light controller or flat rate meter; electrical scientific and experimental work; nickel, copper and brass plating, etc. The company will also be Canadian agents for the Whitney Electrical Instrument Company, as heretofore.

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